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# SCIENCE

17 October 1958

Volume 128, Number 3329

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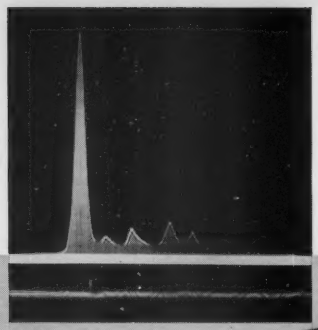
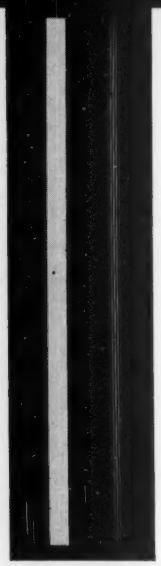


*Electrophoresis of human serum diluted 1:6; ascending boundaries. Inclined knife-edge schlieren and Rayleigh fringes.*



*Typical reference fringe pattern obtained from standard production model.*

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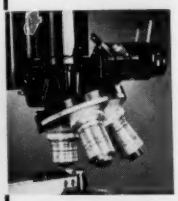

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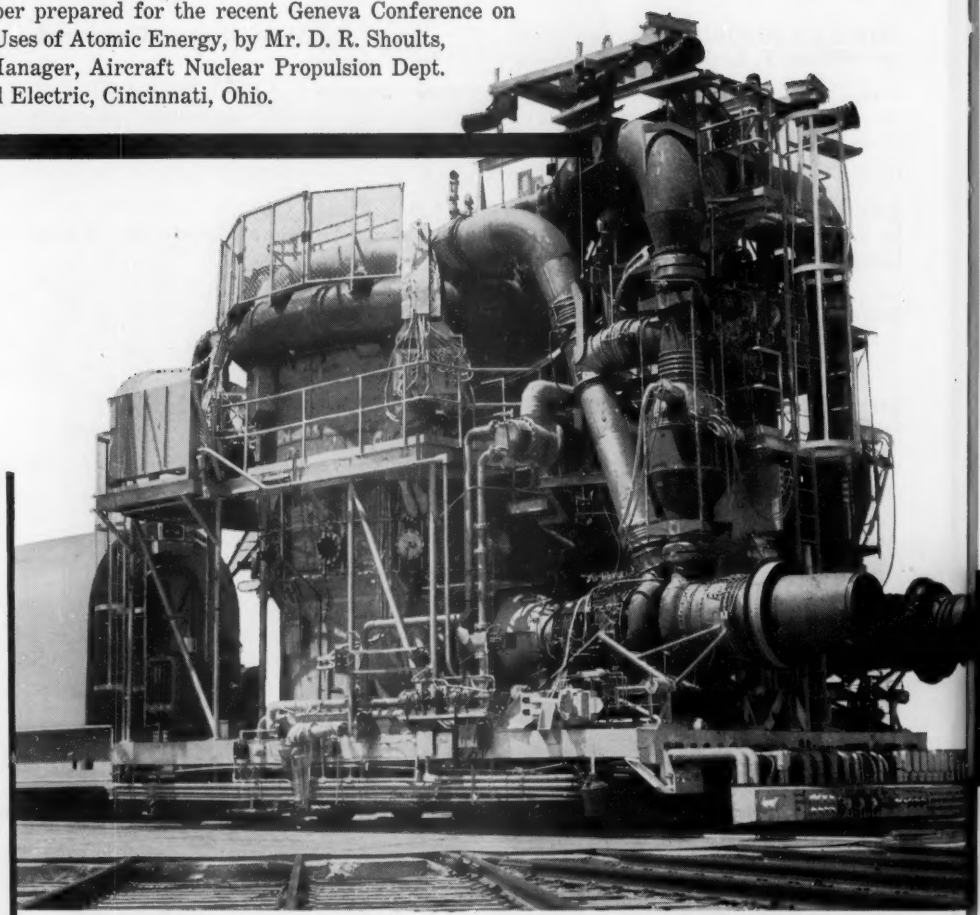
**ENGINEERS, SCIENTISTS:** Specific Experimental Data have now been declassified from which you can gauge the breadth of the opportunities for original work open to you in the pioneering field of nuclear power for aircraft. This information is made available from a paper prepared for the recent Geneva Conference on Peaceful Uses of Atomic Energy, by Mr. D. R. Shoults, General Manager, Aircraft Nuclear Propulsion Dept. of General Electric, Cincinnati, Ohio.



Test Assembly for HTRE No. 1 to the right is on its way to test area on a flat car, drawn by a shielded locomotive. Test area control center itself is underground for safety considerations. During test period, the *Direct Cycle Nuclear Turbojet System* was shut down between operating phases and the Test Assembly returned to the "*Hot Shop*" (a chamber with 7 ft. thick concrete walls and 6 ft. thick windows) where remote handling equipment, designed for this program, disassembled components for the inspection or replacement of parts.

# FIRST PHOTOGRAPHS, DIAGRAMS AND TECHNICAL DATA RELEASED O HISTORIC TESTS PROVING FEASIBILITY OF DIRECT CYCLE NUCLEAR TURBOJET SYSTEM FOR AIRCRAFT

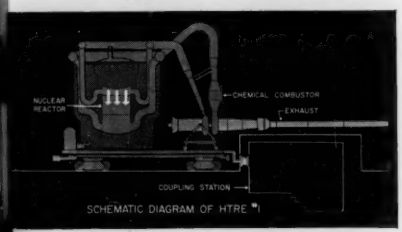
# *Successful Heat Transfer Reactor Experiment No. 1 Basis of Present Advanced Development Stage of Aircraft Nuclear Power Plant*

HTRE No. 1 marked *the first time* that all the components of a combined reactor and jet engine power plant were assembled and operated.

The system was developed and produced by General Electric engineers and scientists at the Aircraft Nuclear Propulsion Department, Cincinnati, Ohio, under dual contract with the U.S. Air Force and the U.S. Atomic Energy Commission. The tests were conducted at the National Reactor Test Station in Idaho Falls, Idaho, during the period January 1956-January 1957.

"These tests," Mr. Shoults writes, "were of great significance in meeting the objective of developing a useful aircraft nuclear propulsion system. HTRE No. 1 proved conclusively the operability of the system and the predictability of its performance."

The Test Assembly for the experiment consisted of an air-cooled, metallic-fuel-element, water-moderated reactor operating a modified J47 turbojet engine designated X39. *A photograph of this assembly is reproduced at the left; schematic diagram below shows a simplified version of the air flow path through the system.*



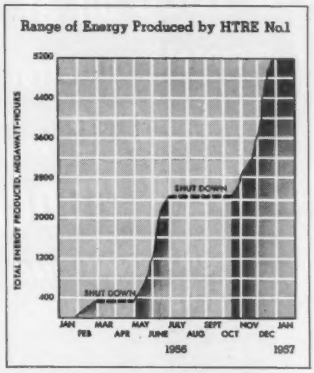
SCHEMATIC DIAGRAM OF HTRE #1

**Test Assembly utilizes the direct air cycle to which propulsive thrust is provided by sending atmospheric air from the compressor (compressed to 5 times the intake pressure) directly through reactor, into the turbine, and out exhaust nozzle.**

The reactor core structure consists of a cylindrical water vessel penetrated by air tubes. The shield plug structure and the heavy gamma ray shielding are of stainless steel. Moderator water is used for neutron shielding in shield plug.

The power plant is started on chemical fuel alone, with compressor air passing through the cold reactor. As the reactor power increases, the chemical fuel flow is decreased. When nuclear power is sufficient for self-sustaining operation, chemical fuel is cut off.

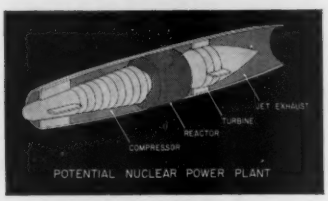
Throughout the tests, operation was stable during the transition from chemical to nuclear power and the reactor was responsive to both manual and automatic control. Combined operating time during test period totalled 258 hours. *A chart showing total energy produced in test period is reproduced below.*




### *Confirmation of Design Concept of Direct Cycle Nuclear Turbojet System Obtained*

Extensive operation at full nuclear power was recorded without failure or significant leakage of radioactive material to the airstream. Proof was obtained that overheating portions of the reactor would not lead to local flow starvation and progressive overheating.

Much of the apparatus illustrated was provided for developmental convenience and would not be used in an actual system for aircraft. The shield, for example, is extra-heavy to allow external contact maintenance during shut-down. In an aircraft installation the shield would be much lighter and the engine would be coupled more closely to the reactor-shield assembly. *A diagram of a potential configuration for a Direct Cycle Nuclear Turbojet System for airframe application is shown below.*



POTENTIAL NUCLEAR POWER PLANT

### *2nd and 3rd Generation Nuclear Power Plants for Aircraft Now Under Development*

Research and development has proceeded at an accelerated pace at General Electric, since the epochal results of HTRE No. 1 in early '57.

The great challenge of the aircraft nuclear propulsion project is that this type of system requires generation of large amounts of heat from a nuclear reactor of very small volume. Also, all items comprising the power plant must be provided within very stringent weight limitations.

Intensive work has been — and is — under way in areas of reactor design, shield design, and the development of new materials to withstand extreme temperatures and neutron bombardment, as well as new methods of fabricating these materials.

While much progress has been made, many problems must still be solved before the first high performance aircraft flies on nuclear power.

**ENGINEERS and SCIENTISTS:**

If you are interested in joining the professional staff now working in breakthrough areas on the Aircraft Nuclear Propulsion Program at General Electric — and have the necessary qualifications for any of the technical fields described below — *your inquiry will be welcomed.*

A majority of these openings do NOT require previous nuclear experience.

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## Selecting the Next Generation

The traditional method of selecting the next generation of scientists is highly personal: the master chooses his own apprentices, arranges some method to help finance their graduate education, tutors them for several years, and then sponsors them as they seek positions of their own. The masters are usually satisfied with this method, and can justify it by a large number of successes. But perhaps their satisfaction also reflects the common tendency to be blind to one's own errors. The statistically minded critic is always skeptical of a situation in which the same person makes a decision and then decides whether that decision was good or bad.

It is difficult to investigate the accuracy of many masters in selecting their own apprentices. But one can study the supplementary methods used in large fellowship programs such as that of the National Science Foundation. Under this program, the Office of Scientific Personnel of the National Academy of Sciences–National Research Council arranges for panels of scientists to review statements of each candidate's research plans, transcripts of his academic record, his scores on standardized examinations in his field of special interest, and statements by scientists who are acquainted with his earlier work. On the basis of this information each panel rates a number of candidates with whom the panelists are not personally acquainted.

Ordinarily, geologists select graduate students in geology, chemists select those in chemistry, and so on. But is such segregation of the candidates necessary? Could geologists do as good a job as chemists in selecting future chemists, or could a mixed panel of scientists? It would frequently be more convenient to set up the panels if it turned out that they could. Yet common sense says that scientists know their own field better than do their colleagues in other fields, and that they might therefore be biased in judging candidates in their own fields. Without deliberate intent, without in fact awareness of what he is doing, a judge might give a higher rating to a candidate in his own field because he understands better the candidate's research proposal, gives greater weight to recommendations from people whom he knows, or evaluates more highly grades in courses in his own field.

The Office of Scientific Personnel has studied this question of bias, in several ways, over several years, with various kinds of panels of judges, and in sufficient detail to reach a clear and convincing conclusion: there is no bias. Some candidates are rated above others, and the candidates in one field may average higher than those in another, but the differences are in the candidates, not the judges. Fellowships go to the same candidates whether they are rated by scientists in their own field or in other fields. (Details are available in the Office of Scientific Personnel's *Technical Report No. 12.*)

This is a comforting finding. It speaks well for the objectivity and integrity of the panels of judges. It means that one need have no misgivings about the use of interdisciplinary panels in selecting fellowship holders. But it leaves unanswered the more fundamental question of how often fellowships are awarded to the right, and how often to the wrong, candidates. The scientist-judges are free from bias, but that does not mean that they are free from error. The Office of Scientific Personnel is studying this point also, and in due course will have some interesting things to say about the validity of their fellowship selection techniques. It is too bad that similar studies cannot be made of the master choosing his own apprentices, for it would be fun to compare the batting averages of the two methods.—D.W.

# The place of the Particle Accelerator in Basic Research...

## Neutron Activation Analysis-XI

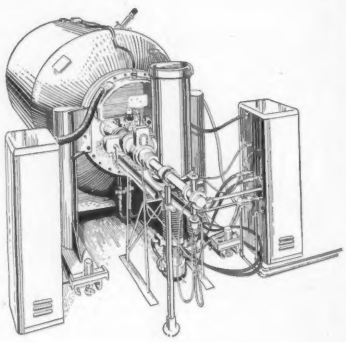
The irradiation of most atomic nuclei by very slow (thermal-velocity) neutrons causes these nuclei to become radioactive. The subsequent emission of beta or gamma radiations from these nuclei is characteristic of the particular isotope. If the *energy* and *rate of emission* of the radiations are known, the isotope can be identified.

The *magnitude* of the radioactivity is directly related to the amount of the isotope present in the neutron-bombarded sample. Since the detection of radioactivity is an extremely sensitive technique, to the point that individual particles or quanta of radiation can be counted, neutron activation analysis permits the accurate appraisal of very small amounts of an element — often smaller than can be readily detected by normal analytical techniques.

### Advantages in Activation Analysis

Neutrons are able to pass through a considerable thickness of most substances. It is possible, therefore, to analyze materials in solid, liquid, or gaseous phases, usually with a minimum of sample preparation. A relatively short time is expended in a single analysis — an advantage where large numbers of samples are involved. The radioactivity created in the process is, for the most part, of short duration and low intensity, necessitating only reasonable care in the handling of the bombarded samples.

Neutron activation analysis is a relatively new technique whose



Horizontal 3-Mev Type K Van de Graaff giving neutron output up to 6 × $10^{11}$ neutrons per second.

scope is limited only by the ingenuity of the analyst. For example, isotopes which appear to be insensitive to the thermal-neutron activation method can often be detected by fast-neutron reactions or through charged-particle bombardment.

### The Van de Graaff® as a Neutron Source

Prolific neutron outputs are obtainable from Van de Graaff positive-ion accelerators, from the $Be^9$ (d, n) $B^{10}$ reaction. The neutrons from this reaction emerge from the beryllium target in all directions with an angular distribution which is not quite isotropic, but has an assymetry in the forward direction of the deutron beam of about 2:1.

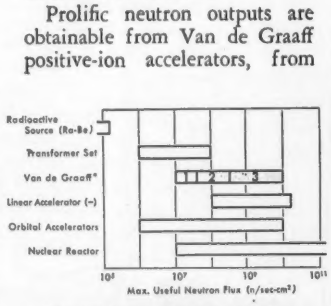



Chart showing comparative neutron fluxes obtainable with various sources. (The numbers in the Van de Graaff bar designate the maximum voltage ratings of the accelerators).

The neutrons emerge with energy groups in the 0.7- to 7-Mev range. To slow these energetic neutrons down to "thermal" velocities (in the region of 2200 meters/second, corresponding to about 0.02 ev), a moderating mass of paraffin, water, or similar hydrogenous material surrounds the neutron-producing target. Inside the moderator, thermal neutrons travel in all directions, producing a neutron flux measured in terms of neutrons per second passing through an area of one square centimeter (n/sec-$cm^2$).

Samples can be placed inside the moderator for neutron bombardment, by inserting them into a hole about 2 cm from the target, to take advantage of the maximum flux. Reasonably large samples can often be accommodated in the volume within a 6-cm radius from the target, with a flux variation less than a factor of two, especially if they are aqueous solutions or organic materials.

***Activation analysis offers solutions to many serious problems in research or in process control. Detailed information about activation analysis, including tabulation of thermal-neutron activation characteristics of the isotopes, is available on request.***

HIGH VOLTAGE ENGINEERING CORPORATION

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17 October 1958, Volume 128, Number 3329 SCIENCE

CURRENT PROBLEMS IN RESEARCH

# Air Conservation

## With discovery of the sources and chemical reactions of pollutants, the stage is set for conservation.

A. J. Haagen-Smit

Our confidence in the abundance of the four principal elements of our forefathers has been severely shaken in recent times. We have learned that the increasing population will have less and less room in which to grow its crops and keep its cattle. Coal, oil, and gas reserves have definite time limits, and we might have had to face a major war over water rights had our ancestors not been wise enough to create a United States of America. Finally, our supposedly infinite supply of air has turned out to be limited, too. With the advent of atomic energy, many of these problems can be solved, but the universal use of atomic energy will make the problem of keeping our air fit to breathe even more difficult. Now we are concerned with constituents present in concentrations of a few parts per million. The future, and part of the present, generation must worry about the removal of pollutants present in quantities smaller by a factor of many powers of ten. In this more efficient cleaning process, the theoretical knowledge and technical skill required will be far greater than the knowledge and skill available today.

Perhaps we should even be grateful that in recent years air pollution disasters and near disasters have developed on such a scale that they have attracted the attention of the whole world. Such an episode occurred in London, when, during a black fog period in 1952, some 4000 excess deaths were recorded. Other disasters drawing world-wide attention were those in Donora, Pennsylvania, Poza Rica, Mexico, and the Meuse Valley in Belgium (*1*). In each of these incidents dozens of people met their death by suffocation.

In recent years, the smog conditions developing in Los Angeles and in other cities on the Pacific Coast have greatly inspired a more intensified effort to clean the air all over our country (*2*). Keeping the air clean is expensive. In the Los Angeles area alone it is estimated that several hundred million dollars have been spent already to curtail some emissions, and many more will have to be spent before the smog will again be unnoticeable. At the present time the air-pollution-control authorities, working against a 4 percent increase in population, are doing somewhat better than holding the line. Over the whole nation the expense will be staggering and will probably run into billions of dollars.

It is understandable that there has been a great deal of resistance to the installation of costly control equipment which often does not contribute in a direct manner to profits. Some of the objections have been removed in recent years, and it is now generally conceded that damage from air pollution is large and that recovery measures often pay for themselves and in some cases may even make profits. Corrosion due to the emission of various chemicals is a source of tremendous expense to the public. Recovery methods will reduce this corrosion and will also lower the cleaning bills for the outside, as well as the inside, of our houses. But even if no direct profit is made, the many intangibles make it worth while to improve working conditions. The standard of living of the workers is raised, and possible adverse effects on their health are eliminated. This contributes to an increased efficiency on the part of the worker. It also raises the value of the industrial property and of the surrounding real estate. In many cases, management has gone much further than merely curing existing air pollution problems. At the present time, climatological and topographical conditions are examined carefully in selecting the site for new industry, and in the construction of new buildings the installation of air-pollution-control equipment is considered beforehand, rather than at a time when public relations have suffered a severe setback.

The old slogan, "Prosperity is measured by the number of smoking stacks," is no longer true. Today, prosperity can be gaged by the number of strange-looking bulges protruding from the roofs of the factories. These bulges are dust- and fume-collectors and indicate that the community and its industry have progressed to a standard of living and social consciousness that does not permit objectionable emissions to spread over other peoples' property. Many modern factories and offices have installed in the air-conditioning system air-purification systems as well, since experience has shown that clean air is healthier and leads to less absenteeism and, in addition, keeps cleaning and redecorating costs at a minimum. Scientific laboratories, too, have found that the protection from plant damage, from interference in the sensitive enzyme systems, and from destruction of oxidant-sensitive organic compounds which can be obtained by air purification is worth while.

Less satisfactory, from a hygienic point of view, is the way many of us spend our day undergoing fumigations with tobacco smoke and engine exhaust

Dr. Haagen-Smit is professor of biochemistry at California Institute of Technology, Pasadena.

—a combination which for many years has been under suspicion where its effects on health are concerned.

One of the most common forms of air pollution is that caused by smoke. A cross-country trip by airplane should convince anyone that smoke is a problem in every great city from Los Angeles to New York. Large streamers, extending for scores of miles, have their origin in open burning dumps, lumberyards, steel mills, foundries, and power plants, to name only a few of the multitude of sources. This is an old problem; some 200 years ago laws were passed in England to regulate the burning of certain types of coal. Even today, combustion is still a major source of air pollution.

At first sight this problem of controlling the emission of smoke appears quite simple—just wash it out! But we have only to think how tobacco smoke from a Turkish pipe bubbles, seemingly undisturbed, through water, to realize that perhaps this problem is not so easily solved after all. Large particles of soot and dust can readily be removed in settling chambers, or in cyclones, where gravitational or centrifugal forces are used to separate the particles by weight. Other methods consist in filtering out the dust through cloth made of cotton, woven plastics, or even glass fibers, in structures known as baghouses. For very fine dust, of the order of from 0.5 to 1.0 micron, we have to apply processes whereby the electrically charged particle is removed by electrostatic forces by passage between electrodes kept at a potential difference of 15,000 to 40,000 volts. A comparison of particle size of effluents and the means of their recovery is shown in Fig. 1. By catching the particles of a size close to the wavelength of light, an important fraction of the dust responsible for the scattering of light is removed, and therefore the probability of visible plume formation is substantially decreased. The process is attractive to industry because of the low cost of maintenance and the negligible drop in pressure, and it is commonly used in open-hearth furnaces in steel mills and in coal-burning plants (Fig. 2). Recently its use was extended in Los Angeles to the control of stack emissions from oil-fired boilers in power plants. Each one of these dust-collection processes has found wide application in industry, but even today systematic studies to increase their efficiency would be most welcome.

The dust present in fuel is not the only agent responsible for an objectionable plume from smokestacks. Virtually all other constituents of flue gas—water, carbon monoxide, and oxides of sulfur and nitrogen—play some role. It is interesting to watch this plume formation take place in a long glass tube through which the hot stack gases are led. As soon as the gases cool below the dew-point range, we see a deposition of metal salts, largely in the form of sulfates, along the side of the tube. Next we find a region of droplets, containing insoluble dust embedded in an acid solution of metal salts. Finally, on further cooling, the bulk of the water, containing some sulfuric acid and sulfur dioxide, condenses. When the gas stream, cooled to outside temperature, leaves the experimental stack, it escapes largely as a plume of water vapor containing trace amounts of sulfuric acid, and nearly all the sulfur dioxide and nitrogen oxide, in gaseous form. In this passage very little sulfur dioxide has been converted to sulfuric acid. The dew point of the outlet is close to that of the outside temperature, and only slight heating is required to cause the visible plume to disappear. This practice is followed in many installations where weather conditions are conducive to plume formation.

We expect that phenomena similar to those observed in the glass tubes take place when the gases are released from the stack, with the droplet size adjusting itself to the outside temperature and humidity. This is an important factor in the variability of plume density observed in otherwise identical combustion conditions. The formation of droplets by condensation is not the end of plume formation, for both sulfur and nitrogen oxides, as well as metal salts, participate in a series of reactions leading to a gradual oxidation of sulfur dioxide into sulfuric acid, and of nitric oxide into higher oxides and nitric acid.

Laboratory investigations by Johnstone and Coughanowr (*3*) have shown that oxidation of sulfur dioxide takes place slowly by photochemical action. These authors estimated that about 1 percent would be oxidized per hour in intense sunlight. This would indicate that in an atmosphere containing 0.1 to 1.0 part per million of sulfur dioxide, about 100 hours of sunlight would be required to decrease visibility to about 1 mile. In continuation of these experiments it was found that oxidation occurs much faster in water solution under the influence of metal salts. Such conditions could conceivably occur in droplets present in the stack plume. The suggestion has been made that it is this reaction which is responsible for the haziness observed at considerable distance from industrial establishments. Evidence that such oxidations do take place when the gases have left the stack is found in an interesting pollution balance made at one time by

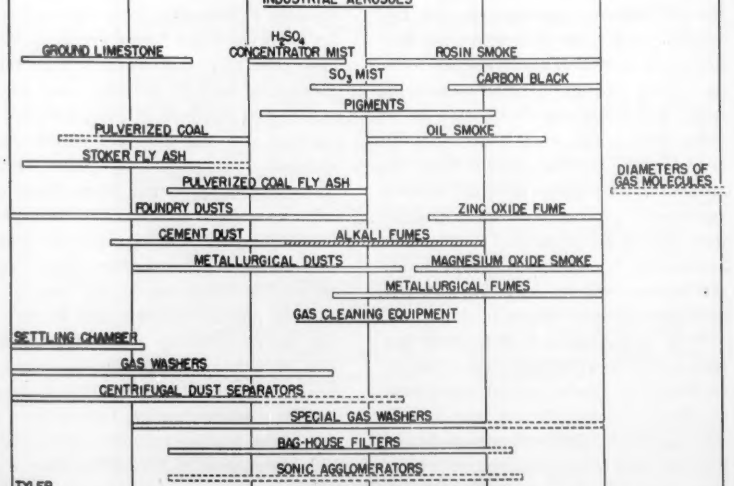



Fig. 1. Particle size chart illustrating relative size of well-known particulates and the effective range of various control methods. [H. P. Munger, "The spectrum of particle size and its relation to air pollution," in L. C. McCabe, *Air Pollution* (*2*, chap. 16)]

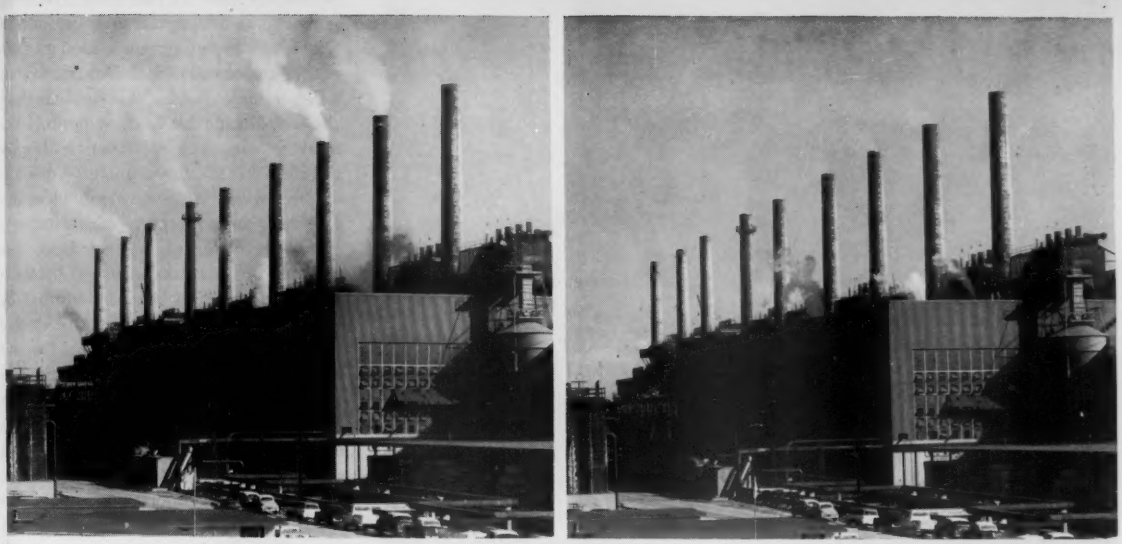


Fig. 2. Before the installation of smoke-control equipment, the normal operation of the open-hearth furnaces at Kaiser Steel Corporation's Fontana, California, plant produced smoke which was released directly into the atmosphere. These two pictures, taken within minutes of each other, graphically demonstrate the effectiveness of the electrostatic precipitator on top of the building. (Left) Picture taken with all the units temporarily shut off. (Right) Picture taken a few minutes later with the equipment back in operation, showing clear sky. [Kaiser Steel Corporation]

the Los Angeles County Air Pollution Control District (*4*). The amount of emission of sulfur dioxide from all sources—refinery operations, oil burning, and gasoline consumption—is well known. We also know the area in which this emission is dispersed, as well as the height of the inversion layer which limits its upward movement. From these data we are able to calculate the expected sulfur dioxide concentration and compare this with the actual observed average concentration. We find, in making up this balance, that about half of the sulfur dioxide is lacking, as is shown in Table 1. This missing sulfur dioxide is found mostly as calcium and ammonium sulfates in dust settling over the country. Free sulfuric acid, except in close proximity to the stack, is virtually absent.

Research work on the effects of stack gas constituents on plants and animals is still an important field of environmental hygiene. Only recently some interesting data were revealed on the synergistic effects of aerosols and oxides of sulfur on physiological responses such as flow resistance in the respiratory system (*5*). This specific air pollution problem illustrates how much work has to be done before we can really understand the phenomena connected with the emission of dust and fumes. Some of this work is in the field of engineering, and other aspects deal with inorganic, physical, physicochemical, and photochemical processes. Finally, we have problems in physiology and pathology of plants and animals, as well as legal and economic problems.

## Los Angeles Smog

Notwithstanding its many facets, this control problem is simple compared with a more recently discovered air pollution problem which threatens to affect all metropolitan areas. It is an oxidized hydrocarbon type of pollution, better known as Los Angeles smog, from its place of discovery (Fig. 3).

During the war years, Los Angeles was suddenly surprised to find itself engulfed in an eye-irritating cloud of chlorine-like odor. This incident lasted about a year and was generally attributed to the emissions from a synthetic-rubber plant. After the control of these emissions, complaints stopped, only to be resumed after the war. The rubber plant could not be blamed this time, for it was closed, nor could sulfur dioxide and soot be blamed for the severe eye irritation. As a matter of fact Los Angeles is a very clean city in this respect, with a dustfall of only 20 to 30 tons per month per square mile, as compared with several times this quantity in other industrial cities. There is no resemblance at

Table 1. Comparison of measured and calculated concentrations of pollutants in downtown Los Angeles (*4*, p. 41).

| Pollutant | Clear day* (parts per million by vol.) | | Day of intense smog† (parts per million by vol.) | |
|---|---|---|---|---|
| | Measured | Calculated | Measured | Calculated |
| Carbon monoxide | 3.5 | 3.5‡ | 23.0 | 23.0‡ |
| Oxides of nitrogen | 0.08 | 0.10 | 0.4 | 0.6 |
| Sulfur dioxide | 0.05 | 0.08 | 0.3 | 0.5 |
| Total hydrocarbons§ | 0.2 | 0.40 | 1.1‖ | 2.6 |
| Aldehydes | 0.07 | 0.02 | 0.4 | 0.1 |
| Organic acids | 0.07 | 0.03 | 0.4‖ | 0.2 |

* Visibility, 7 miles.
† Visibility, less than 1 mile.
‡ The method defines the calculated value as the same as the measured value for CO.
§ Calculated as hexane.
‖ Preliminary values.

Fig. 3. Dense smog over Los Angeles Civic Center. Note how the buildings project above the base of the inversion layer, while pollution remains below. [Los Angeles County Air Pollution Control District]

all to the problems of cities in the eastern part of the United States, where coal is the major source of energy and where, consequently, soot blackens all buildings. The eye-irritating clouds in Los Angeles are accompanied by complaints from farmers about crop damage (Fig. 4) and, strangely enough, from rubber manufacturers, who observed that their products cracked more heavily in this area than in other sections of the country (Fig. 5). Control of dusts and sulfur dioxide did not help, for the phenomena are due to an effect quite different from the more old-fashioned, reducing type of air pollution. Los Angeles smog, contrary to this type of pollution, is typified by its strong oxidizing action (*6*, *7*).

For practical measurement of the typical oxidizing effect of Los Angeles smog, liberation of iodine from potassium iodide, oxidation of phenolphthalin to phenolphthalein, and many other oxidation-reduction reactions can be used. For an explanation of the effect of oxidizing smog on living tissue, its demonstrated action on amino acids such as cysteine, tryptophan, and histidine, as well as on glutathione and lysozyme, is significant and might well account for the irritating symptoms. The measured oxidant action is caused by an excess of oxidizing over reducing components in the polluted air. In Los Angeles smog the concentration of sulfur dioxide, a reducing substance, is low, and its effects are usually negligible. In other areas, the presence of the oxidizing pollutants may well have escaped attention because of the masking effect of an excessive amount of reducing substances. It is quite possible that the oxidizing pollutants which characterize Los Angeles smog are of more frequent occurrence than was originally suspected.

The concentration of the oxidant varies during the day, increasing toward noon and decreasing to virtual absence during the evening and night hours. The time of increased concentration of the oxidant is invariably correlated with eye irritation and haze. The type of damage to plants from oxidizing pollutants is readily distinguishable from damage from other types of pollutants, such as sulfur dioxide or fluoride. Sensitive plants—spinach, sugar beets, alfalfa, endive, oats, and pinto beans—are used extensively to gage the spread of the pollution (Fig. 6). A major part of the oxidant consists of ozone, which is directly responsible for the excessive rubber cracking observed in the Los Angeles area. Spectrographic, as well as chemical, methods have definitely established the presence of ozone concentrations 20 to 30 times higher than those found in unpolluted air, where the normal concentration amounts to 1 to 3 parts per hundred million.

A simple and inexpensive method of measuring ozone involves the use of bent pieces of antiozodant-free rubber as indicators (Fig. 7) (*8*). The time necessary for the appearance of the cracks is directly related to the ozone content of the air. At night, and on smog-free days, it may take as long as an hour for the first cracks to appear; on a smoggy day, cracks are often evident in a matter of a few minutes, under the conditions of the test. During heavy smog periods the total oxidant concentration is higher than can be accounted for on the basis of the presence of ozone alone when determined by spectrographic methods. This excess oxidant, corrected for the action of oxides of nitrogen, consists mainly of peroxidic material formed by the atmospheric oxidation of organic material. These organic peroxides are held to be responsible for eye irritation and plant damage resulting from smog. In the atmosphere over a city it is to be expected that the reactive ozone will enter into reactions with a number of other pollutants. Among the most prevalent of these groups are olefins, present in gasoline; fumigation experiments with gasoline fractions, and also with pure olefins which have been allowed to react with ozone, led to a reproduction of the typical plant-damage symptoms and to eye irritation, haze formation, and typical smog odor, as well. These experiments strongly indicated that the irritating materials were intermediate oxidation products of hydrocarbon oxidation and are of peroxidic nature, since the usual end products—aldehydes, ketones, and organic acids—are inactive in the concentration range used.

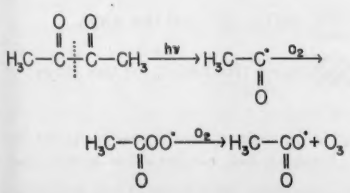
Most organic compounds are relatively stable against oxidation, when completely pure, but the presence of peroxides speeds the auto-oxidation considerably through a chain reaction initiated by hydrogen removal from the hydrocarbon chain. This effect can be accomplished also through the action of light on either the hydrocarbon or the oxygen molecule. In the latter case, the excited oxygen may remove hydrogen. Most hydrocarbons do not have absorption bands in the wavelength region of sunlight for a direct photochemical reaction. Similar reactions can be accomplished in a roundabout way by having a substance present which accepts the light energy and subsequently transfers it to the compound to be oxidized. In nature we find such substances in chlorophyll and other photochemically active pigments. In polluted atmospheres nitrogen dioxide functions as an oxidation catalyst in this way. Strong absorption of light by nitrogen dioxide occurs from the near ultraviolet through the blue part of the spectrum, and, upon irradiation, nitrogen dioxide splits into atomic oxygen and nitric oxide. Fumigation experiments with

gasoline or olefin in the presence of oxides of nitrogen resulted in eye irritation and the same type of plant damage that was previously obtained with ozone acting on the olefins directly. In this case, too, we are able to calculate the concentration of hydrocarbon which should be present in a certain area and compare this with the actually observed concentration, just as we have done with the sulfur oxides. We find that the hydrocarbon concentration in the air is less than it had been calculated to be; on the other hand, the concentrations of the oxidation products—aldehydes and acids—are considerably higher than had been calculated, as is shown in Table 1. All these observed facts are in harmony with an explanation of Los Angeles smog as an oxidation phenomenon of organic material.

Fig. 4. Severe damage on the under side of spinach leaves caused by Los Angeles smog. [Los Angeles County Air Pollution Control District]

### Formation of Ozone

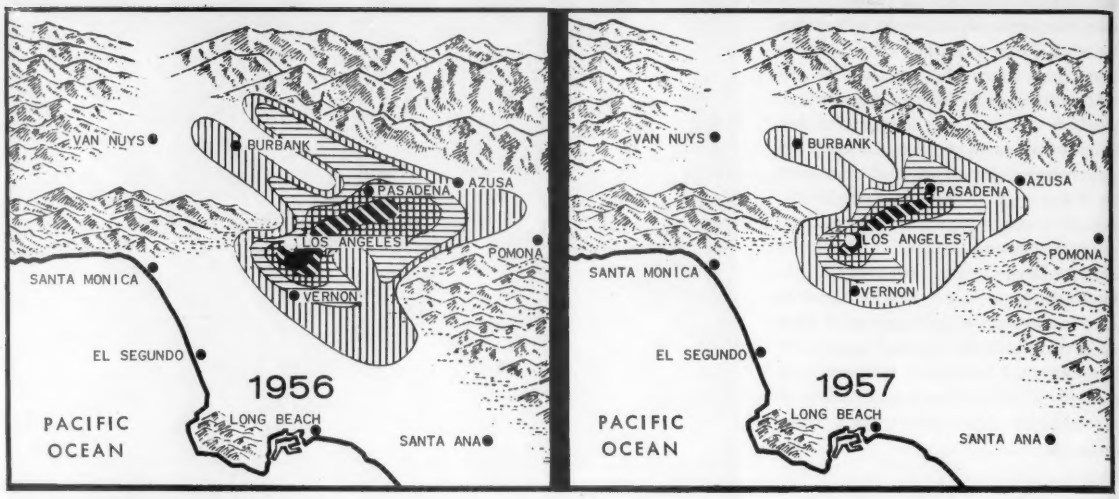
When all the typical symptoms of smog had been reproduced, the problem remained of accounting for the relatively high ozone content in the polluted atmosphere. It is now well established that the generation of ozone is intimately connected with the same photochemical reaction of organic material and oxides of nitrogen which causes eye irritation and plant damage. The formation of ozone is apparently a general phenomenon and is observed with many types of hydrocarbons, as well as with alcohols, ketones, aldehydes, and acids. The production of ozone has been attributed to the intermediate formation of peroxide radicals. This hypothesis is supported by the behavior of a model substance, biacetyl, upon irradiation. Years of photochemical research have shown that this diketone dissociates predominantly into acetyl radicals, which are further decomposed into methyl radicals and carbon monoxide. In most of these photochemical experiments the presence of oxygen is rigorously excluded to avoid complication. When oxygen is admitted, the free radicals will form peroxy radicals, and these apparently react with more oxygen to yield ozone:

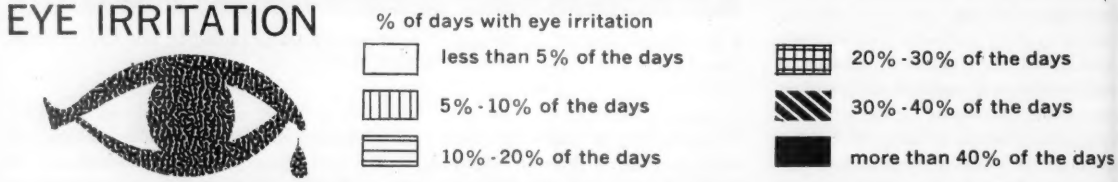


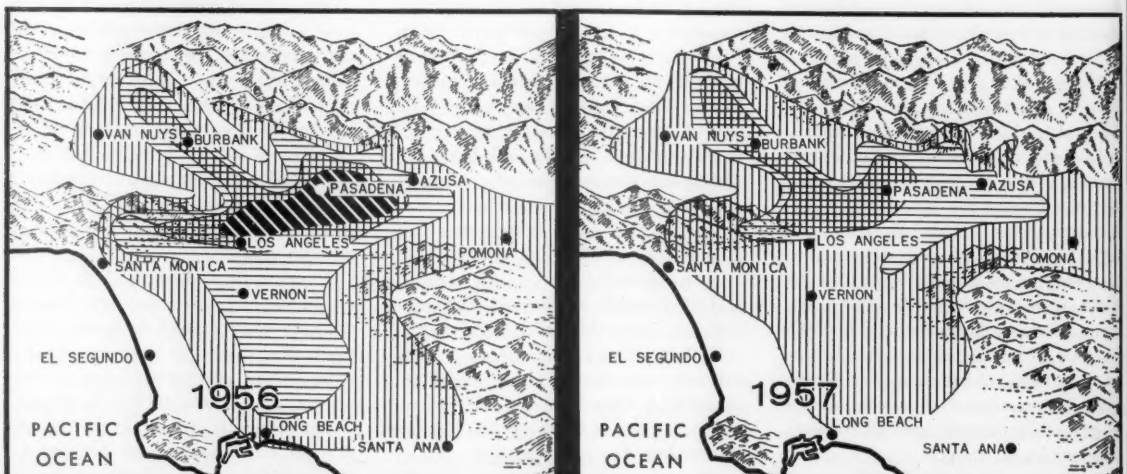
This rather surprising result can readily be verified by a simple lecture experiment in which a drop of biacetyl is introduced into a Pyrex flask. Next, a small piece of rubber with the ends tied together to form a loop is suspended in the flask. After exposure for an hour to sunlight, the rubber is heavily cracked, due to ozone attack. The rubber used should not contain antiozodants, of course. Infrared investigations have confirmed the chemical analysis and indicate that we are really dealing with ozone. Another well-known instance of radical formation is the irradiation of alkyl nitrites whereby an alkyl radical and nitric oxide are formed. When irradiation is carried out in air or oxygen, the alkyl radical forms a peroxide radical and ozone formation can readily be established. This reaction is similar to that postulated in the formation of smog of the Los Angeles type. The starting products in that case are nitrogen dioxide and hydrocarbons or their derivatives. We may visualize, first, a light-activated dissociation of nitrogen dioxide to nitric oxide and atomic oxygen, followed by a reaction of the atomic oxygen with a molecule of oxygen to form ozone. Atomic oxygen may also abstract a hydrogen from a hydrocarbon, with formation of an alkyl radical. This, in turn, can form ozone, as shown previously in the case of biacetyl. Also, reactions between nitric oxide and alkyl and alkylperoxy radicals may take place. Representatives of such combinations have been found in long-path infrared studies conducted by workers at the Franklin Institute (*9*). Especially interesting is the formation of a peracylnitrite, a direct combination product of the photochemically produced nitric oxide and peroxy radical. This compound appears in smog atmospheres as well as in irradiation of synthetic mixtures of hydrocarbons and nitrogen oxides. It is postulated that these types of compounds play an important role as intermediates in the reoxidation of the nitric oxide to nitrogen dioxide.

A systematic study of the area of concentrations of hydrocarbon and oxides of nitrogen where ozone formation takes place showed that the reaction is limited to quite low concentrations of the reactants, as is shown in Fig. 8. Experiments of this type have focused attention on the circumstances peculiar to the problem of air pollution—that is,

Fig. 5. Severe rubber cracking observed in Los Angeles area. [J. W. Haagen-Smit]





EYE IRRITATION
% of days with eye irritation
less than 5% of the days
5%-10% of the days
10%-20% of the days
20%-30% of the days
30%-40% of the days
more than 40% of the days



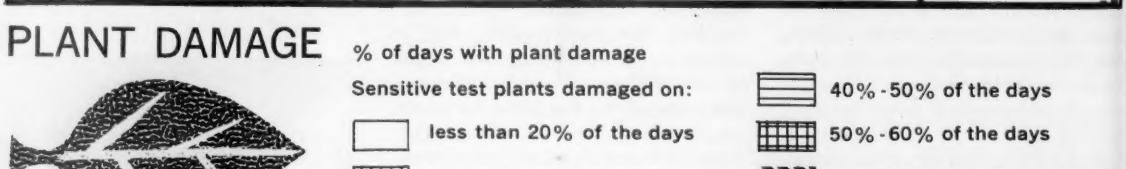


PLANT DAMAGE
% of days with plant damage
Sensitive test plants damaged on:
less than 20% of the days
20%-40% of the days
40%-50% of the days
50%-60% of the days
more than 60% of the days

Fig. 6. The effect of air pollution control in the Los Angeles area for the period 1956–57. The intensity of eye irritation (top) has decreased, as has the area over which eye irritation is observed. Reported plant damage (bottom), too, has been less severe. [Los Angeles County Air Pollution Control District]

the extreme dilution. A chemist referring loosely to slow and fast reactions has in mind the conditions in laboratory synthesis, where concentrations of about 10 percent are most commonly used. In atmospheric reactions the concentrations are in the order of 0.00001 percent—about one millionth as much. As a result, reactions which under the usual laboratory conditions are considered fast become very slow. For example, when a bimolecular reaction with participants in the concentration range of 10 percent (100,000 parts per million) requires 0.0036 second to go halfway to completion, it takes $10^6$ times as long, or a whole hour, to reach the same point with a concentration of 0.1 part per million. Under the latter circumstances, not only can ozone survive attack by reducing agents but even free radicals have a far better chance of survival. It took many years to unravel relatively simple reactions such as the photodecomposition of acetone, biacetyl, and other compounds. In the air these reactions are complicated by the presence of oxygen, water, carbon dioxide, and an almost infinite variety of organic compounds from the evaporation and combustion of gasoline and from the burning of trash in its many forms.

## Theoretical Investigations

The field of atmospheric reactions is now being actively studied by a number of physical chemists and provides an interesting example of the way in which a practical problem has stimulated a number of theoretical investigations. Such study has familiarized a large group of physical chemists with the exciting field of extreme dilution, in which research should prove to be far less disturbed and complicated than research at higher concentrations, where molecules collide all too frequently. In addition, the practical aspects of air-pollution photochemistry have made available the instrumentation necessary to study these phenomena from a theoretical point of view. The purely theoretical physicist and chemist would have difficulty in obtaining the millions of dollars which have gone into the development of these instruments. It is gratifying to find that, as a by-product of the study of an unpleasant problem such as air pollution, a significant contribution to fundamental problems in chemistry could be made.

## Automobile Exhaust Fumes

These remarkable reactions have now been confirmed in at least four different laboratories and provide a firm basis for control measures. We know which compounds contribute to these reactions and we know their sources, and now the Air Pollution Control District has only to control hydrocarbons, their oxidation products, and the oxides of nitrogen. Unfortunately, the necessary control equipment cannot be ordered because it still has to be invented. After hydrocarbons at refineries have been recovered, the major remaining source of hydrocarbons is the exhaust of automobiles, which amounts to 1200 tons per day. Direct and catalytic afterburners and deceleration devices are now being developed, but even after a successful device has been produced it will take many years before such devices will be installed on all the cars in the Los Angeles area. Pressing air pollution considerations can now be added to the many other arguments for streamlining our transit systems.

There are other difficulties. The major contributor to the oxides of nitrogen is, again, the automobile, and, apart from injection of water into the cylinders and the combustion of very rich fuel mixtures, no means are yet available for reducing the oxides of nitrogen. Several engineering laboratories are now searching for ways to reduce the nitrogen dioxide content of exhaust gases from gas, oil, and gasoline combustion through studies on the variable combustion conditions which can be obtained through boiler modification or changes in engine design. Often the question has come up, "Can't we do one or the other—hydrocarbon control or nitrogen dioxide control?" The answer, I believe, is "No." Most of the smog reactions are directly dependent on the product of the concentration of both hydrocarbons and oxides of nitrogen.

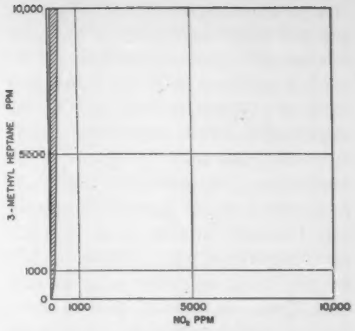



Fig. 8. Area of ozone formation with 3-methylheptane and $NO_2$. Ozone formation takes place only at concentrations indicated by shaded area (10,000 parts per million, volume for volume, is equivalent to 1 percent). [A. J. Haagen-Smit and M. M. Fox, *Air Repair* (7)]

The private automobile is a major offender in both respects, and there is no reasonable basis for hope that control devices in the hands of the average car owner will give anywhere near the performance they give in an automobile-testing laboratory. Also, changes in gasoline composition could not be expected to have a drastic effect on smog-producing hydrocarbons in the exhaust. The steady increase in population tends to neutralize any control effort, and it is therefore evident that emissions must be controlled wherever possible. Besides be-

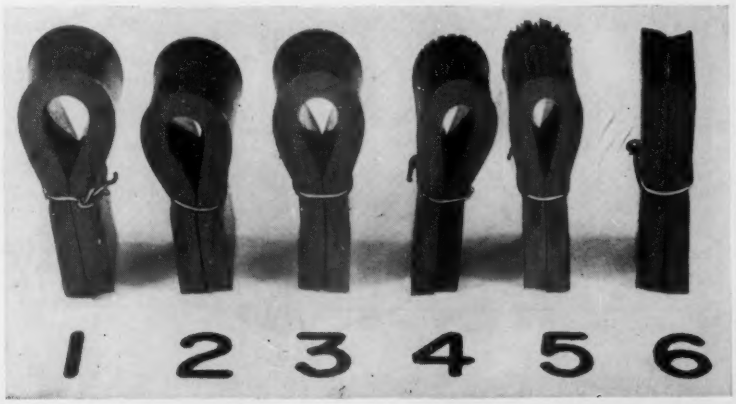



Fig. 7. Ozone in air is measured by its effect on rubber under strain. The degree of cracking indicates the concentration. [Los Angeles County Air Pollution Control District]

ing an objectionable factor in the photochemical reactions, the nitrogen oxides are objectionable in their own right and are quite toxic even in low concentrations. Fortunately we have not yet reached anywhere near the lower alert limit of 5.0 parts per million, but the concentration of this pollutant is steadily increasing, and since it appears in all combustions, the increase is practically proportional to the increase in population. Especially in areas of heavy traffic the concentration might at times surpass the safe limits, or, rather, what we now believe are safe limits. Oxides of nitrogen are rather unpleasant compounds. In concentrations of only 25 parts per million they act like war gases such as phosgene and cause lung edema. It is quite possible that, at far lower doses, objectionable damage might occur.

### Cigarette and Cigar Smoke

Oxides of nitrogen are prominent in a quite different form of air pollution. Cigarette and cigar smoke contains from 300 to 1500 parts per million of oxides of nitrogen, which is completely removed by inhalation, through adsorption in the lungs. No attention has been given to this agent as a causative factor of respiratory ailments in smokers. Its strong toxic action should be an inducement to study more intensely the volatile components of tobacco smoke than has been done in the past, when most attention has been given to nonvolatile tars containing carcinogenic hydrocarbons.

Air pollution control administrations have a difficult task in surviving the years of waiting for engineering to catch up with the demands of the community. Programs for meeting emergency conditions have somewhat contributed to better feelings on the part of the public. It is understandable that most people not accustomed to smelling or inhaling a concoction of ozone, oxides of nitrogen, ozonides, and substances *x*, *y*, and *z* begin to be a little worried. In recent years the medical profession in Los Angeles has set certain levels below which a catastrophe would be unlikely to occur. This is admittedly a very difficult decision to make and it has pointed to a serious deficiency in our knowledge of environmental hygiene.

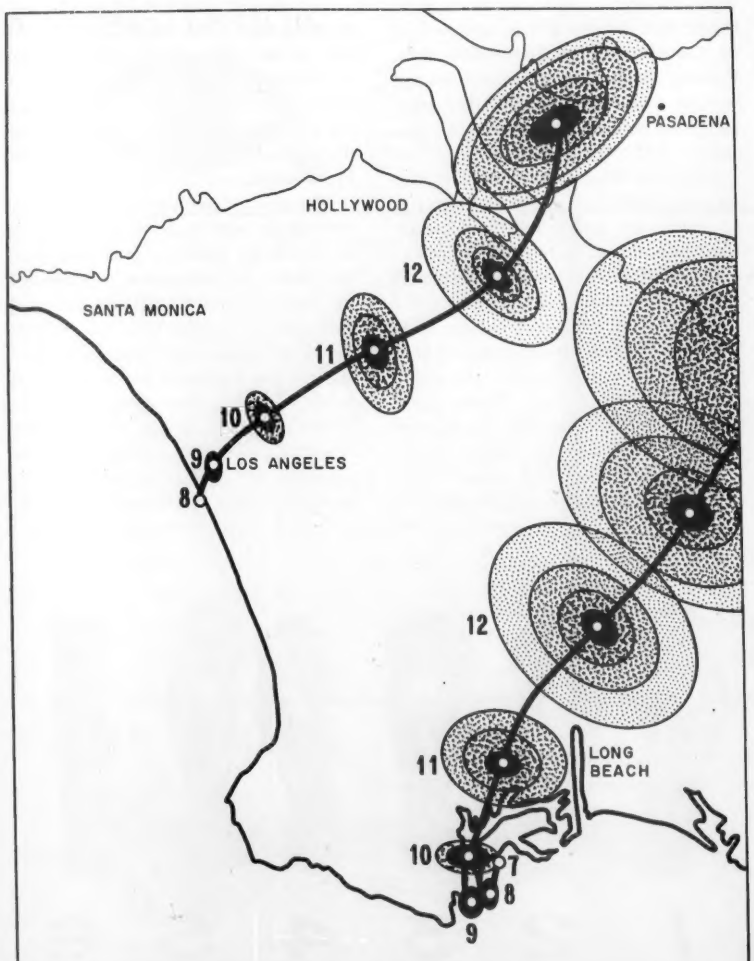



Fig. 9. Hypothetical dispersion of smoke puffs released at two points of the Los Angeles basin at 7 A.M. and 8 A.M., respectively. [F. N. Frenkiel (*11*)]

### Pollution Levels

In studies of the health effects of air contaminants it becomes evident that there is a great difference between the industrial and general population levels. The industrial group generally represents a selected group of healthy individuals from which the extrasensitive have been removed, because the working conditions do not agree with them. For the whole population such a selection does not take place to any large degree, and we are dealing with the oversensitives—the sick, the young, and the very old. Public health officers have a most difficult task in establishing pollution levels for such a heterogeneous group, and it is a foregone conclusion that when levels are finally adopted there will be those who will maintain that they are too high, while others will charge persecution of industry because the levels are set too low. Animal experiments, and even experiments with human beings, while indicating some level of toxicity or annoyance, cannot give the answer for a general population. In urban areas we are dealing with several million people, and many would call the death of one or two persons per million, or some 20 for a town the size of Los Angeles, a disaster. The impossibility of approaching this accuracy of prediction in an experimental human, or even animal, colony is evident, for we would have to experiment with a few million individuals to get a statistically valid answer.

We come, therefore, to the conclusion that the only person able to give answers with any certainty about the result of some large-scale fumigation is the epidemiologist gathering data on death rates and general health status. It is, of course, unfortunate that this kind of study comes too late to prevent the dis-

aster; on the other hand, these studies furnish extremely valuable data on ways to prevent recurrence of the same series of events. It is for this reason that the study, such as that by workers at Harvard, of pretoxic effects, consisting in physiological responses warning of the danger ahead, is one of the most promising approaches to the study of pollution levels. These studies deal with the combined and synergistic effects of aerosols and sulfur dioxide. The physiological changes noted are greater flow resistance in the respiratory system, as reported by Amdur and Mead (*10*). The effects found at lower concentration do not necessarily represent toxic symptoms but may have to be regarded in the same class as sneezing, coughing, or blinking of the eye—therefore as warning signs and pretoxic symptoms.

Air pollution disaster can be prevented. Even nuisance effects can be minimized by planning at the right time. Such planning requires some basic information which can be furnished by the meteorologists. A study must be made of wind trajectories, for the progress of a package of air loaded with pollutants over the area should be known. Also needed are data on the change in concentration in a pollution cloud as it moves across a given area. This change comes about through turbulence and chemical reactions. As in the case in Los Angeles, relatively harmless gases may react to form irritants while moving across the basin. We like to know how long it takes for the pollutants to react sufficiently to give us maximum irritation.

When all these facts, plus the size and nature of the emission, are known, we can begin to think of plotting the trajectories and the isopollution lines for different substances. This kind of calculation has been described by Frenkiel (*11*) for a hypothetical case in the Los Angeles area. The calculation, which, practically, can be made only by means of electronic calculating machines, shows the fanning out of the emission from a single point of origin and its gradual dilution (Fig. 9). When we are dealing with a diffuse source such as the automobile, we can divide the area into a number of smaller areas for which traffic density, and therefore pollution, are known (Fig. 10). By calculating and integrating each one of these contributions, we arrive at the effect of a multiple source of pollution such as the automobile. This method, more than any other, shows clearly the contribution made by different sources, often miles away, to the pollution at a particular spot. Anyone enveloped by the expanding cloud will experience nuisance effects, regardless of whether or not he is in the exact center. On the basis of this concept, it is possible to express quite clearly how strongly the individual contribution from different sources may vary from one location to another, although both are in the same general area. Almost everyone is aware of this fact. Nevertheless it is quite common to refer loosely to minor and major sources, completely losing sight of the fact that in certain neighborhoods a local nuisance may have a greater effect than larger sources located far away. A great deal of friction could be avoided by recognizing this simple fact, and

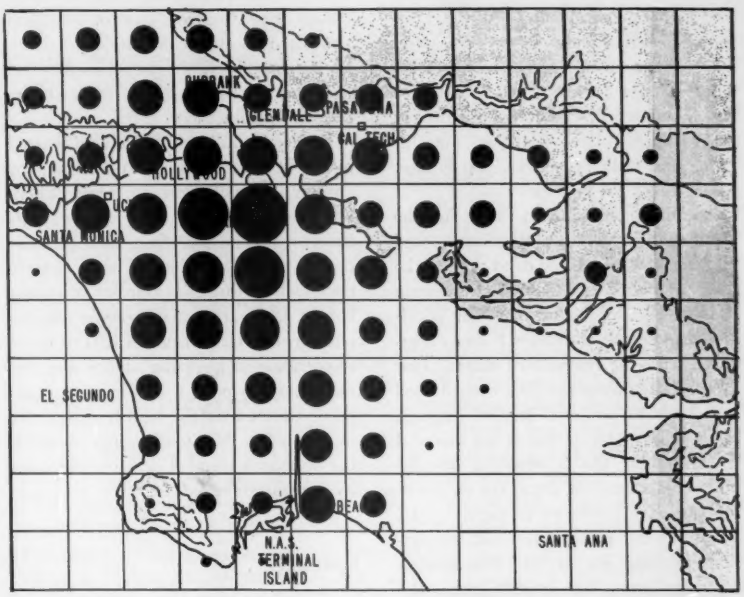



Fig. 10. Geographical distribution of traffic in the Los Angeles area. Area of circles is proportional to the number of vehicles; each square represents 16 square miles. [F. N. Frenkiel (*11*)]

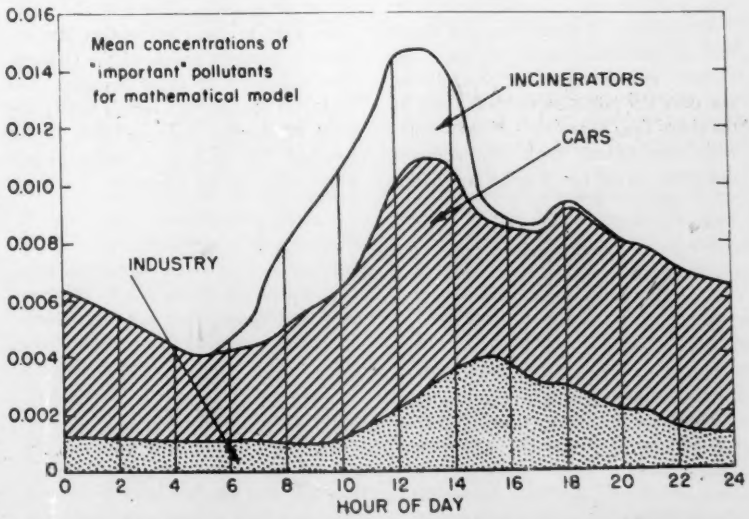



Fig. 11. Relative contributions of the three principal pollution sources to the mean concentration at California Institute of Technology. The effects of topographical features and inversion are taken into account in the mathematical model of Los Angeles County. The relative proportions of the "important" pollutants emitted by the three principal sources are based on recent studies in Los Angeles County. [F. N. Frenkiel (*11*)]

Frenkiel's "relative contribution charts" for different locations could be of great help in objectively settling some of the hot arguments (Fig. 11). A prerequisite for such calculations is reliable information on wind directions. Tracer studies based on the addition of easily identifiable materials such as fluorescent substances to the stack gases may be helpful. Much cheaper is the tracing of natural components specific to some of the sources. Aerial photography also offers considerable promise, especially at times when plumes 10 to 20 miles in length can be observed. Closer cooperation of other organizations, such as the Air Force and military and civilian groups, would be of great help.

Application of the methods for the calculation of pollutant distribution and movement would allow us to predict the future development of smog at a certain location and to predict what the elimination of certain sources will do as compared with the removal of others. This is especially important for a complicated case such as we find in Los Angeles. Here, most of the hydrocarbon material is emitted by the automobile, but the other components of smog, the oxides of nitrogen, are produced in nearly equal quantities by automobiles and installations burning gas or oil. The stationary installations are usually large, the trail of oxides of nitrogen is well defined, and the concentration of oxides of nitrogen may be higher than could be expected from a pollution cloud from such a diffuse source as the automobile.

Climatological conditions, and therefore air pollution moved by the wind currents, do not respect legal boundaries, nor does the pollution suddenly stop at the shore line, beyond which it is somewhat more difficult to maintain observation posts. In the Los Angeles area basin, for example, pollution from the southern industrial area can reach the Los Angeles Civic Center by either a land or a sea route. Federal and state testing programs have drawn attention to these wind movements, which cause pollutants to drift as far as islands 50 miles off the Pacific coast. These pollutants can readily be seen from the air and are quite different in appearance from low-lying clouds, due to their lack of structure and often to their characteristic yellowish-brown, off-white color, caused by refraction rather than by any color of specific chemicals.

Earlier in this article I have discussed more or less regularly occurring, or chronic, air pollution problems. There is, however, a more acute type of pollution which occurs when, through accidents such as explosions of tanks of toxic chemicals or through explosion of enemy bombs, large areas may become dangerous. In such circumstances it is of great importance to have the ability and the machinery to push a button on a computer which tells the health authorities in only a few minutes the area to which the poisonous cloud is drifting and what its concentration will be.

## Conclusion

Air pollution problems are as varied as the activities of people themselves. We have looked in some detail at only two types of pollution. It has been my intent to make it clear that the problems met in air conservation are extremely complex and need the cooperative assistance of many scientific and technical disciplines. There is hardly any field of human endeavor that is not touched. The student of environmental hygiene has, as his laboratory, hundreds of square miles; as his chemicals, about everything a population emits to the air —in other words, a mixture representing a sizable portion of the inorganic and organic chemicals. His accomplishments have to be attuned to a population so varied in reactions and responses that an "average" person has no meaning in his problem. Entering into and often interfering with the normal occupations of the community, he has to be endowed with diplomatic and legal talents. The increased importance of his job in protecting the cleanliness of the air is felt in many quarters, and several universities and federal agencies have started courses in practical and theoretical aspects of air pollution control. Needed, too, are engineering studies to lead to the improvement of existing methods and to the invention of more efficient and economical processes to deal with old and new problems in air pollution.

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# Coming Problems of U.S. Economic Development

A review of two volumes of specially prepared essays by economists, sociologists, and other thinkers.

Victor R. Fuchs

Winston Churchill is supposed to have complained that whenever he asked Britain's three leading economists for an opinion he received four replies—two from John Maynard Keynes. It comes as no surprise, therefore, that when the Committee for Economic Development (a business-sponsored, policy-oriented, economic research organization) asked economists and others to write two thousand words on the question: "What is the most important economic problem to be faced by the United States in the next twenty years?", they received a plethora of answers. Ninety-nine such essays have now been published under the title *Problems of United States Economic Development*, in two volumes (*1*).

Volume 1 contains 49 papers (*2*) which were contributed by invitation. The roster of authors is impressive. It includes six past presidents of the American Economic Association: J. M. Clark, Paul Douglas, Alvin Hansen, Frank Knight, Simon Kuznets, and Sumner Slichter. Several outstanding foreign economists are represented—for example, Colin Clark, Nicholas Kaldor, Robert Marjolin, Lionel Robbins, and Jan Tinbergen—as well as a sprinkling of distinguished writers from other fields, among them Henry Steele Commager, Julian Huxley, Reinhold Niebuhr, and David Riesman.

Volume 2 contains 50 papers which were chosen for publication (and awards of $500 each) from 1238 entries in a contest sponsored by the Committee for Economic Development. Most of the authors represented in this volume are economists, but a professional writer, a Harvard Law School professor, and a banker and other noneconomists were also among the winners.

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## Picture of American Society

What do the 99 essays add up to? Is there a composite picture of America which emerges—a picture which delineates in broad terms our economic present and future? What do we, as a nation, see when we look in the collective mirror of our minds?

According to these essays, we see a well-dressed, well-fed, well-gadgeted, successful, albeit potentially erratic, middle-aged businessman. Through a combination of thrift, hard work, and some luck, he has become very wealthy, but he is surrounded by poor neighbors, who endanger his security and peace of mind and sometimes even trouble his conscience. He spends a sizable portion of his income for police protection but still does not really feel secure and wonders if there might not be some alternative.

At home, his children give considerable evidence of being "spoiled" and seem to be dissipating his wealth in an extravagant and rather purposeless manner. He is not in a good position to criticize them, however, since he has always encouraged their preoccupation with conspicuous consumption. He is worried about his own old age (the problem here is only partly financial), and at the same time he is faced with the task of providing adequate education and housing for an enormous crop of grandchildren. He has a strong distaste for "politics," but he finds that many of the most pressing problems of the day are not handled adequately by private enterprise, and that government must play an increasingly important role.

He has accepted a certain amount of control over his business in the interest of stability, but he is not sure that government can really fulfill on that promise. After having first fought the unions and then acquiesced in their growth, he now finds himself wondering whether the power of organized labor does not pose new problems of stability and equity. Moreover, he has an uneasy feeling that the tremendous growth and bureaucratization of his own business imperils some of the freedoms which he has always considered his most precious heritage.

Most important and most troublesome of all, he must ask himself what kind of person he really is and what he wants to become. The dreams of his youth have been, to a great extent, fulfilled. He must now dream new dreams, grander dreams, and pursue them with even more determination, intelligence, and compassion than he showed in the past. As Moses Abramovitz wrote in one of the most stimulating of the invited essays, we as a people, must ". . . define useful and worthy ends, and balance our efforts among them in due proportion" (*3*).

## Internal Problems

This is the over-all picture; we may now examine the essays in somewhat greater detail.

The reviewer of these essays is faced with an almost insurmountable problem. It obviously is not feasible to say something about each; on the other hand, the essays do not fall easily into a simple system of classification. In preparing the papers for publication, the committee made two tries at grouping them according to subject (the categories of volume 1 do not correspond to those of volume 2) and neither is very satisfactory. My own attempt appears in Table 1.

We may first make a basic distinction between those papers which saw the "most important problem" as one which was *internal* to this country (that is, would exist even if the United States were alone in the world) and those essays which discussed *external* problems (problems involving United States relations with the rest of the world). Slightly more than one-fourth of all papers fell into this latter category; the burden of their argument will be discussed later.

Of the papers concerned with internal

problems, we may distinguish three major and one minor category, plus a miscellaneous group. The largest number of papers was devoted to the perennial problem of stability—that is, the prevention of inflation or depression. More than one-fifth of the writers made this their choice, while a number of others alluded to it but indicated that this is a problem the solution to which is now in hand.

Fear of "creeping inflation" was the dominant theme of the invited papers which dealt with internal stability. In essay after essay the experts expressed concern about the slow but persistent deterioration in the value of money. Most of them related it to the over-all commitment to full employment, coupled with the strong bargaining power of organized labor.

The contest winners were evenly divided between those who saw inflation as the major stability problem and those who stressed the possibility of another depression. The writers in the latter category stressed the historical instability of the American economy, the problem of maintaining a balanced rate of expansion of investment and consumption, and the difficulty of persuading the government to initiate, and the public to accept, those programs which would help to avert a major depression. On the whole, however, this represents an area in which there has been a tremendous change in thinking in the past decade. If these volumes had been published at the end of World War II, it is safe to estimate that at least 50 of the papers would have listed a possible depression as the number one problem.

Hard on the heels of the papers dealing with stability was an interesting group of papers devoted to the problems of economic growth. Very few of the writers were concerned about America's capacity or ability to grow in quantitative terms, but they were disturbed by the directions of growth and by the stresses and strains which accompany growth. In these papers there is little of the type of discussion which might have been offered by natural scientists about the depletion of natural resources as a growth-inhibiting factor. Instead of engaging in a discussion of means, most of the writers on growth were concerned about ends. In the words of contest-winner Werner Levi, "The great problem of future economic development in America will be how to influence its direction so that it may serve the cause of human freedom and dignity" (*4*). Or, as sociologist David Riesman wrote, "This searching of aims and discovery of motives seems to me the fundamental economic task in an age of abundance" (*5*).

Table 1. Distribution of papers according to subject, based, in part, on a few very arbitrary designations.

| Type of problem | Invited papers | Contest papers | Total |
|---|---|---|---|
| External | 20 | 6 | 26 |
| Internal | | | |
| Stability | 8 | 13 | 21 |
| Growth | 8 | 10 | 18 |
| Freedom | 5 | 8 | 13 |
| Location and urbanization | 5 | 2 | 7 |
| Miscellaneous* | 3 | 11 | 14 |
| Total | 49 | 50 | 99 |

* This category includes education, housing, problems of older people, and so on.

In third position among the internal problems was the question of freedom. For a few, this meant a concern over freedom of enterprise, but for most of the 13 writers in this category, the problem encompassed freedom for the individual in many varied aspects of life.

Writers on the subject of freedom fall into two main groups. There are those, such as Frank Knight, Milton Friedman, and John Jewkes, who see the principal threats to individual freedom residing in government, monopolistic labor unions, and the decline of free enterprise. On the other hand, Paul Douglas and several of the contest winners see the giant corporations as the greatest potential threat to freedom. Even if the giants acquire "corporate consciences," as Adolf Berle recommended a few years ago, the problem would still be with us, according to one contest winner, Roswell G. Townsend. He wrote, "The paradox is that the more the modern corporation accepts its own *public* importance, the more its managers succeed in living the good life in business affairs, the more effective its 'human relations' with labor and unions, the more it improves the community through fine educational and recreational facilities . . . the more the citizens lose that self-reliance, that independence of thought, that initiative which have made America great" (*6*).

A fourth, and much smaller, group of papers, dealt with problems of location, especially as they manifest themselves in the problems of the urban metropolis. Reginald R. Isaacs, chairman of city and regional planning at Harvard University, estimated that the cost of urban renewal will reach the staggering total of $2 trillion by 1970 (*7*). On the other hand, Luther Gulick, president of the Institute of Public Administration, in another invited paper, dismissed the cost factor and put the blame on "bad political engineering" (*8*), while economist Alvin Hansen saw the problem as a . . . "conflict between a rigidly private enterprise point of view and a social welfare point of view" (*9*).

Some 14 papers which deal with internal problems do not fall into any of the above categories and have been classified as miscellaneous. They include discussions of such diverse subjects as nuclear energy, the consumer, and the need for balance among competing groups. There were many more in the miscellaneous category among the contest papers than in the invited group, and it is not impossible that some element of "gamesmanship" is partially responsible for this diversity.

Two of the most interesting of the papers in the miscellaneous category posed questions which were symptomatic of a general unrest apparent in a majority of the essays—namely, the inability of the United States to meet the problems of tomorrow within the traditional framework of a competitive, free enterprise, profit system. Such a system, it must be remembered, *automatically* offered solutions to the basic social problems of choice of output, allocation of resources, and distribution of income, and at the same time provided a rigorous test of efficiency.

But, according to many of the essays, the problems of tomorrow will require new institutions and standards to supplement markets and profits. Contest-winner Norman H. Leonard, Jr., wrote, "The most important economic problem of the next twenty years is how to develop a methodology and institutions which encourage the public and its policy makers to make choices in the light of a multiple goal system. Each part of economic policy should be examined with respect to . . . the political goals of a free society. By this means economic policy could be related more directly to the ethical end of human existence . . ." (*10*). And in an invited paper, Gerhard Colm, chief economist of the National Planning Association, argued that ". . . the evolution of standards of economic performance and conduct is of the most crucial importance for our economic future. Without the development

of some such standards, I see little chance that the specific economic problems can be solved within the framework of a free and democratic society" (*11*).

## External Problems

The great majority of the essays dealing with external problems stressed one major theme: the need for the United States to assist the so-called underdeveloped countries to achieve a more rapid rate of economic growth. Three principal arguments were advanced in support of this position. First, it was argued that a failure to solve this problem will drive these countries to communism, will block efforts to promote peace, and will endanger the *security* of the United States. Peter Drucker wrote, "We share today throughout the world a common goal, a common belief and a common commitment: The goal of economic development. . . . If the promises of Economic Development should be disappointed, however, international class war of the many very poor against the few very rich would become unavoidable. This would be a class war against the United States . . . such a class war would mean victory for world Communism" (*12*). Allusions to such an international class war can be found in many of the papers.

Second, a substantial number of writers suggested that the United States has a *moral* obligation to help other countries. Paul Homan wrote, "The upward striving of the human race depends upon attitudes; and I do not think that a satisfactory state of civilization can be achieved in the United States so long as it entertains a tribal attitude toward the rest of the human race. . . . We have it in our power, with little sacrifice, to give them a fair fighting chance to improve their condition . . . one cannot be neutral toward the consequences of hugging all our mounting prosperity to our own breasts. Unless animated by the right spirit and administered with a view to moral obligations, there is a better chance that it will corrupt and demean us than the contrary" (*13*).

Finally, a few writers urged foreign aid on the grounds that it would help the United States economy. But this argument was usually placed last and often seemed to be thrown in as an "extra," possibly to give the problem more of an "economic" aspect, or to placate those who pride themselves on being "practical."

The preponderance of invited as opposed to contest papers in the "external" category requires some explanation. It probably reflects the fact that a large number (19) of the invited papers were contributed by foreign writers. Of this group no less than 12 discussed external problems. On the other hand, only two of the contest winners were from abroad. It also may be attributed in part to the wording of the contest invitation, with its emphasis on United States problems. Many entrants probably felt it safer to limit themselves to internal problems.

## Picture of Economics

Thus do the essays sketch the problems of American society at a crucial point in history. But they do something more than that; they also give us a picture of the subject of economics, a picture which is so strikingly different from the one portrayed in the graduate schools and the professional journals as to require some comment.

The past few years have witnessed many significant new developments in economic theory, especially in connection with the application of mathematics to economic problems. Linear programming, game theory, and input-output analysis are among the best known of these advances. Great hopes have been engendered, both within and without the profession, that with this increased attention to new developments in mathematics, economics will become more scientific and more fruitful. As one interested mathematician has written, ". . . classical mathematics has failed rather thoroughly to solve economic problems. Recent investigations of the type discussed here indicate that the fault may not lie in the mathematical approach itself, but in the type of mathematics used" (*14*). These hopes are undoubtedly shared by a great many mathematicians, scientists, and economists, and have had considerable influence on the direction of research and the training of young economists. They may be fulfilled with respect to certain kinds of problems, most notably those involving planning for an individual firm, such as scheduling output mixes and input requirements, inventory control, and negotiations with suppliers and customers. But with respect to the problems posed by most of the essays now under review, such hopes are bound to prove chimerical because they are based on a fundamental misunderstanding of the nature of economics.

As soon as we talk about freedom, justice, moral obligations, and values, we are in an area in which mathematics may help us to think more clearly but can never "solve" the problem. Let us admit at the outset that better theoretical models will never tell us whether we should or should not help the underdeveloped countries or even suggest the form that such assistance should take. Linear programming may be a great asset to the giant corporation but will never tell us whether the giant corporation is, on balance, an asset to our society. And input-output tables are not likely to reveal how we can use our growing command over matter to free man for what has been called "leisure work"—the use of free time for creativity in the arts, sciences, statesmanship, and religion.

It may be said that these are not economic problems. But these surely are the problems which economists have traditionally addressed themselves to. The greatest contributions of the past have been precisely those in which the normative and positive aspects of the subject have been inextricably entwined. In this respect economics is significantly different from the natural sciences, and no amount of mathematical rigor can erase this difference. To test this proposition we need merely examine the seminal works on the subject—for example, *The Wealth of Nations, Das Kapital,* Keynes's *The General Theory of Employment, Interest, and Money.* If we ask ourselves what would be left of these works if they were stripped of all except that which had scientific validity—that is, if they had been written under the same kind of restraints as are considered normal in scientific work—we can quickly appreciate this point.

These essays, therefore, do more than suggest that Americans need to reexamine their goals, their values, and their institutions. They also suggest that economists need to reexamine their own professional goals, research, and training lest they find themselves divorced from the crucial currents of our time. The papers are eloquent testimony to the proposition advanced by J. M. Clark, who wrote, "There are two worlds, the world of impersonal investigation of cause and effect, and the world of desires, ideals and value judgements. The

natural sciences deal with the first, ethics with the second . . . the peculiarity of economics is that it is called upon to bridge this gap" (*15*).


**References and Notes**

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# Radioactivity of People and Milk: 1957

## Measurements of 2200 samples for cesium-137 and potassium-40 levels reveal interesting correlations.


Ernest C. Anderson


The investigations of the gamma activities of people and foodstuffs previously reported for 1956 (*1*), made by means of a large $4\pi$ liquid scintillation counter (*2*), have been continued (*3*). During 1957, dried milk was routinely sampled from 31 locations within the continental United States, and a few spot checks were made on foreign milks. A total of 887 measurements were made on milk. Studies on people included 820 determinations, mostly weekly measurements on a group of 14 control subjects, but 311 determinations on people from 30 states were included. Measurements on a total of 518 samples of dried blood from nine states completed the program. The entire series of 2200 measurements occupied about 20 percent of the operating schedule of the counter and was accomplished by one full-time and one half-time technician (including the data processing).

It is clearly impossible to present here a tabulation of all results or even to give the detailed graphs of activity versus time by states. The original data for 1956, 1957, and part of 1958 are tabulated in *HASL-42* (*4*). This article presents only the broad outlines of the results and indicates the principal correlations which are emerging.

As before, simultaneous measurements of both potassium-40 and cesium-137 were performed on all samples. The unit of measurement for the latter has been changed to micromicrocuries of cesium-137 per gram of potassium, to conform with general practice. Detailed gamma spectrum measurements made with the Los Alamos crystal spectrometer (*5*) have shown that these are the only significant gamma-emitting nuclides in this energy range normally present in people and milk. During periods of weapon testing, barium-140 appears prominently in milk, as previously reported (*6*), but we have not detected it in people. The electronic computation of the data as now programmed does not take barium-140 into account, and barium-140 is treated as if it were potassium-40. Because of the predictability of the potassium content of milk, it is feasible to calculate both barium-140 and cesium-137 from the data, and the programming is currently being revised to accomplish this. In the present article, however, all milk samples showing barium contamination are excluded from the average. The extent and duration of typical barium-140 contamination are illustrated in Fig. 1, which shows the yearly data for fresh milk samples from New Mexico. (Several sources are represented in these samples.)

The absence of barium-140 in people is indicated by Fig. 2, which shows the cesium-137 and potassium-40 activities averaged over 14 control subjects measured weekly. Barium-140 derived from the milk would have produced a rise in the apparent potassium-40 level (lower curve) during the summer months. The increase in cesium-137 level at this time reflects the corresponding increase in the milk supply.

The presence of iodine-131 in either people or milk would not constitute an interference, since the low energy gamma ray does not fall in the spectral bands accepted by the analyzers. The improved liquid scintillation counter now under construction will have additional energy channels for iodine-131 and for beta-ray bremsstrahlung.

### Results

The frequency distribution of potassium-40 in the population sample is shown in Fig. 3. The average specific activity is 2.70 gamma rays per second and pound, corresponding to a potassium content of 1.98 grams per kilogram of body weight, or 139 grams of potassium in the 70-kilogram "standard man." The standard deviation of the normal curve is 14 percent. The average is not significantly different from the 1956 result (*1*), but the deviation is slightly less (the previous figure was 18 percent) and there is no tail on the upper end of the distribution, probably a result of better control over surface contamination.

The corresponding curve for cesium-137 is given in Fig. 4. The width of 36 percent is identical with the 1956 value. The possible significance of the very small difference in the average values (44 and 41 micromicrocuries of cesium per gram of potassium) is discussed below.

The cesium-137 data for people as a


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function of geographic location are given on the map (Fig. 5). In order to obtain statistically significant averages, the states were grouped regionally as indicated. To compare these data with those reported for 1956 (*1*), the latter cesium/potassium ratios should be multiplied by 80. Individual determinations are based on 200 seconds of counting time and, for the average subject, give a statistical precision of better than ± 3 percent on the potassium-40 and better than ± 4 micromicrocuries per gram on the cesium-137. Because of the much larger variations among individuals, the precision of the average is limited by the number of subjects and the adequacy of the sampling. If the sampling is assumed to be random (this is probably not the case because of the frequency of family groups among the subjects), the precision of the regional population averages could be estimated by dividing the standard deviation of the population curve (Fig. 4) by the square root of the number of persons represented in the average. On this basis, many of the differences evident in Fig. 5 are to be regarded as significant.

The 1957 levels of cesium-137 in milk samples from various parts of the United States are given in Fig. 6.

On the basis of the counting rate of a typical 50-pound NFDMS (Non-Fat Dry Milk Solids) sample and average background, the statistical precision resulting from 400 seconds of counting time for the sample and 400 seconds for the background is ± 0.51 percent for the potassium-40 and ± 1.1 micromicrocuries per gram of potassium for the cesium-137 determination. A series of 21 determinations on a control milk sample over the period October 1957 through February 1958 gave an observed random scatter corresponding to a standard deviation of ± 0.87 percent for the potassium-40 and ± 1.3 micromicrocuries per gram of potassium for the cesium-137. This indicates an error slightly larger than statistical for the potassium-40 and an essentially statistical error for the cesium-137. The results, of course, may reflect a considerably larger error on the absolute basis because of systematic errors in counter calibration, and so on.

Sampling points are concentrated in the West in order to encircle the Nevada test site as completely as possible and to take advantage of the fact that the most extreme variations of altitude and rainfall are to be found in this region. The 1958 sampling network has been expanded in the eastern United States to better delineate the indications of structure in the fallout pattern there. The absence of data from the High Plains and the Southeast is a result of the difficulty of obtaining dry milk samples from these areas.

The changes in levels of cesium-137 in the milk from a given locality throughout the year are indications of seasonal variation on which are superimposed transient peaks due to tropospheric debris from weapon tests. Data will be required for a period of several years for the analysis of the seasonal factors, so the averages here reported are based on the entire year, with the exception of those periods during which the presence of barium-140 indicated tropospheric contamination.

Only a limited number of foreign milk samples were analyzed in 1957, since the principal objective of the program was an intensive study of fallout mechanism rather than extensive monitoring. Single samples from England and Japan, respectively, both had a cesium-137 content of 25 micromicrocuries per gram of potassium. Both were produced late in 1956 and, while slightly lower in cesium-137 content, are not strikingly different from samples produced in the United States for this time. Five samples of dry milk from Argentina, produced in November and December 1956, gave an average cesium content of 9 micromicrocuries per gram of potassium, with a range of from 4 to 12. These are definitely lower than Northern Hemisphere values by a factor of about 4. Twelve monthly samples from Australia during 1957 did not indicate such a large hemi-

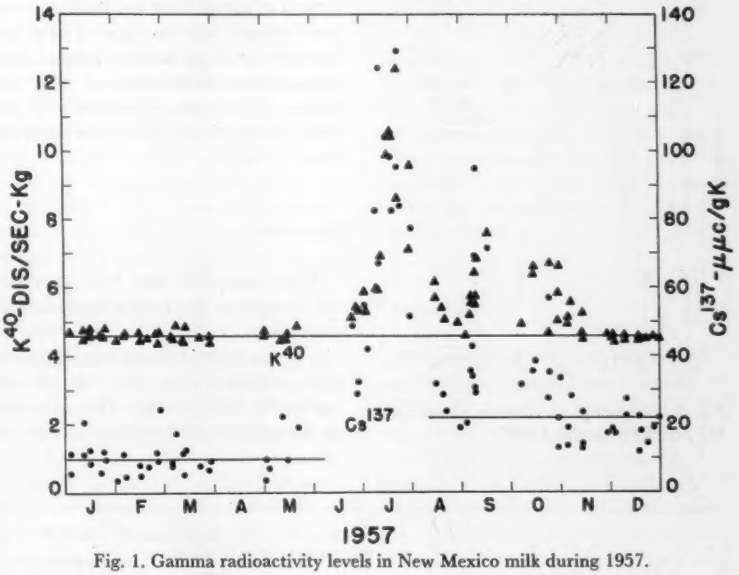


Fig. 1. Gamma radioactivity levels in New Mexico milk during 1957.

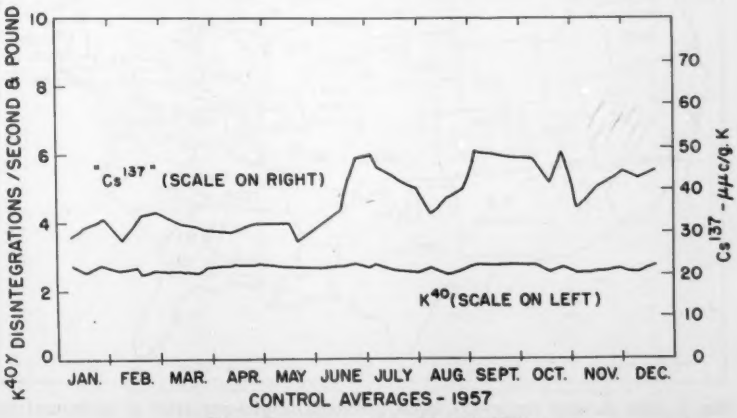
$K^{40}$ DISINTEGRATIONS / SECOND & POUND
$Cs^{137}$ - μμc/g K
"$Cs^{137}$" (SCALE ON RIGHT)
$K^{40}$ (SCALE ON LEFT)
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
CONTROL AVERAGES - 1957

Fig. 2. Data for control subjects (1957).

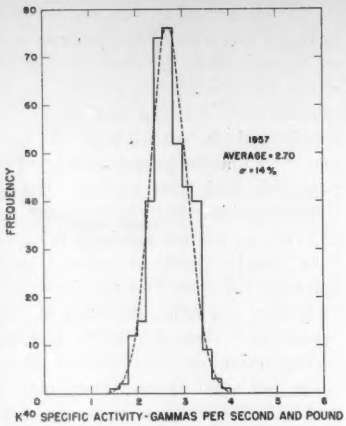


Fig. 3. Frequency distribution of potassium-40 activity in people (1957).

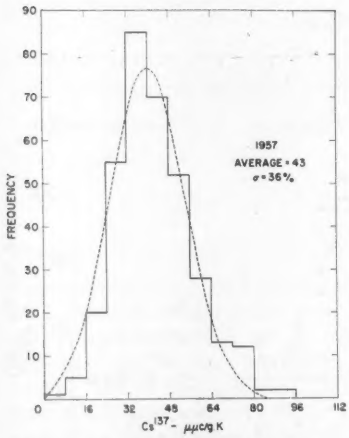


Fig. 4. Frequency distribution of cesium-137 activity in people (1957).

spheric effect, for they gave an average of 18 micromicrocuries per gram of potassium, compared with a range for samples from the United States of 20 to 40 for the same total rainfall. Because of seasonal and other fluctuations, care should be exercised in drawing conclusions from such a limited number of samples.

It was hoped that the dried blood samples would provide a simple and economical method of checking the radioactivity of meat. Unfortunately, this has not proved to be the case. Since the material is destined for use as fertilizer or animal food, it is not prepared under the carefully controlled conditions employed in the drying of milk and is subject to external contamination during processing. This is evidenced by the erratic variations in the activity levels and by the presence of such fission products as zirconium-95 and cerium-144. The latter are absent from the flesh of cows, even animals that have grazed near the Nevada test site, whose rumens show comparatively high levels of these activities (7). For this reason, none of the dried blood measurements are reported here.

## Discussion

There appear to have been no striking changes in the cesium levels in human beings between 1956 and 1957. In Fig. 7, the concentrations in various regions, averaged over 1956, are plotted against the 1957 averages. The variations do not seem to be significant in view of the small population sample available. The consistency suggests that a rather stable fallout mechanism is operating and that a more detailed analysis should help illuminate this mechanism.

Table 1. Observed and estimated changes in levels of cesium-137 in people in the United States.

| Year | Av. Cs level (μμc/g K) | Calculated according to alternative mechanisms | |
|---|---|---|---|
| | | Integrated | Differential |
| 1956 | 41 ± 1.3 | (41) assumed | (41) assumed |
| 1957 | 44 ± 1.1 | 68 | 50 |
| Change | 3 ± 1.7 | 27 | 9 |

A more sensitive analysis for a possible temporal change is possible if the entire United States population average is considered, because of the large sample size.

The average cesium/potassium ratio in the United States population was 41 micromicrocuries per gram during 1956 and 44 micromicrocuries per gram in 1957 (8). These averages were computed by first averaging over certain regions (shown on the map, Fig. 5) and then averaging the regions in order not to give undue weight to states such as New Mexico which are disproportionally represented in the population sample. The number of determinations was 134 in 1956 and 207 in 1957, if the New Mexico sample is reduced to the same size as the samples from other regions. If the standard deviation of the average of $n$ determinations is assumed to be $1/n^{1/2}$ times the observed standard deviation of the population distribution curve (36 percent for both years), then the precision of yearly averages would be 3.1 percent and 2.5 percent, respectively. The difference between the two years is, therefore, $3 \pm 1.7$.

This difference can be compared with the increase expected on the basis of two extreme alternatives. First, assume that all the cesium in soil is unavailable to plants, so that the cesium is derived from direct fallout only. In this case, the cesium should vary as the fallout rate, and hence as the stratospheric inventory. The second alternative is that all cesium in the soil is available to plants, in which case the cesium in man should vary as the total integrated fallout. Intermediate cases are also possible.

Strontium-90 values can be used for the fallout data, if it is assumed that there is no gross fractionation between

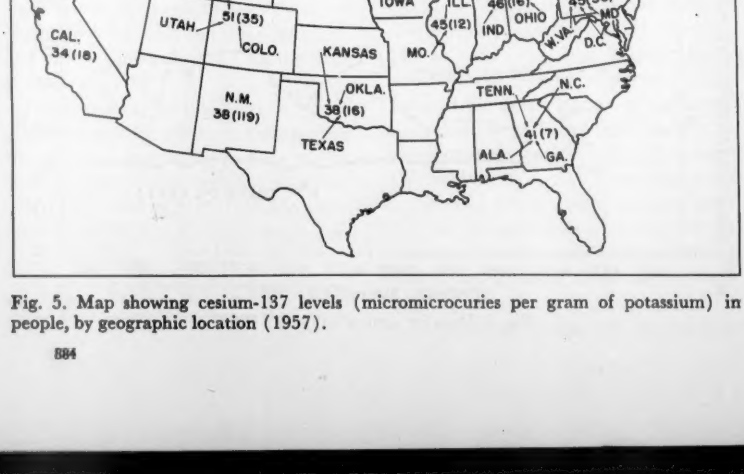


Fig. 5. Map showing cesium-137 levels (micromicrocuries per gram of potassium) in people, by geographic location (1957).

strontium and cesium in the fallout process. We will derive the ratio of the average integrated fallout for 1957 to the average for 1956 from Libby (*9*). These data apply to Pittsburgh and are based on tub collection. Because of the 120-day biological half-life of cesium in man (*10*), the fallout averages are taken over the 1-year period beginning 3 months before the calendar year for which cesium data were obtained. We find the 1956 average cumulated fallout to be 11.3 millicuries per square mile and the 1957 average, 19.4 millicuries per square mile, a ratio of 1:1.72.

Similarly, the ratio of the average rates of stratospheric fallout in the two years can be estimated to be 1:1.23. Table 1 compares the observed cesium increase with that calculated on the basis of these alternatives. These results seem to indicate that direct fallout on the leaves of vegetation is the primary mechanism for cesium-137 entry into the biosphere; this is in agreement with the observed limited availability of soil cesium to plants. However, the result cannot be regarded as conclusive, since Langham and Anderson have shown (*11*) that the observed cesium levels in people are in fair agreement with those calculated on the assumption that uptake from soil is the route of entry.

In Fig. 8, the cesium level in people is plotted against the cesium level in milk from the same areas for 1957. The intercept of this graph for no cesium in the milk indicates that about 23 micromicrocuries of cesium per gram of potassium are derived from a source other than milk. Since milk supplies about 38 percent of the dietary potassium (*1*), the cesium/potassium ratio in the other source must be about 25 micromicrocuries per gram, not very different from the average for milk itself. Most of the other major potassium sources are foodstuffs which are widely exchanged over the country (for example, meat, cereal products, citrus fruits), milk being unique in its localized consumption. Therefore, making a primary local correlation with milk is not unreasonable.

The slope of the line in Fig. 8 is 0.7. If we use, again, the estimate that about 38 percent of dietary potassium is from milk products, this slope indicates a discrimination factor, $(\text{cesium/potassium})_{man}$ to $(\text{cesium/potassium})_{milk}$, of 1.8. The discrimination factor calculated from biological half-life ratios is 120 days to 40 days (*1*), or about 3. The value deduced by Miller and Marinelli on the basis of the ratio of excretion to body burden is close to 2 (*12*).

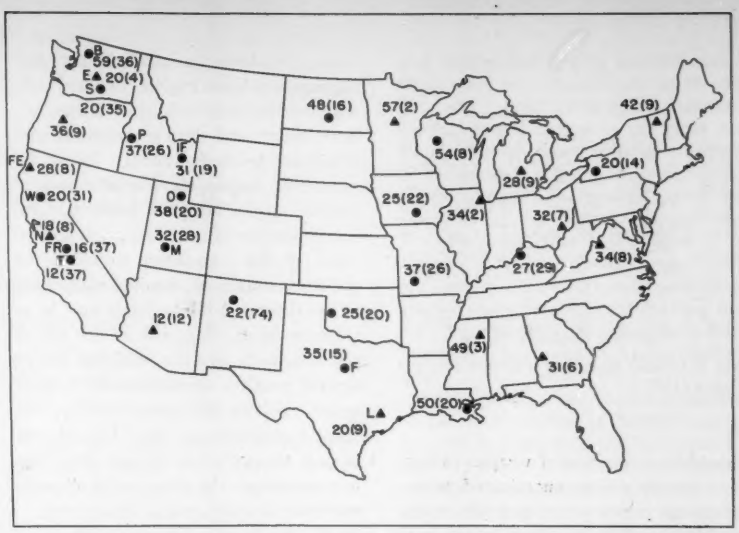


Fig. 6. Map showing levels of cesium-137 (in micromicrocuries per gram of potassium) in milk samples from various parts of the United States (1957).

It has been repeatedly suggested that the intensity of fallout should in some way be related to rainfall, since scavenging by rain seems to be a very efficient process. Such an effect is, in fact, clearly evident in the milk data given in Fig. 6, particularly for the states of Washington and California. We have, therefore, plotted the average cesium-137 content of milk during 1957 against total precipitation (*13*), as shown in Fig. 9. The country divides rather sharply into two regions, each showing a positive correlation but with regression coefficients differing by a factor of 2.6. A similar effect has been reported for strontium-90 in rainfall (*14, 15*). The two regions, as defined by the cesium data, are not separated by a parallel of latitude but rather appear to divide along a line running roughly from El Paso, Texas, northeast to Minneapolis, Minnesota, and thence east through the Great Lakes. Such a division may be explained on the basis of a general tropospheric circulation pattern. The region with a low ratio of cesium to precipitation is the area whose precipitation comes from the south or east, while in the other region the prevailing storm-track pattern is from the west or north.

## Conclusions

The results of the past year's operations indicate that the measurement of cesium-137 is a very useful tool in the study of the fallout process. The internal consistency of the data suggests that the number of variables involved, while large, is not insuperably so. Given a moderate expansion of the sampling system and a few more years of operation, one can hope to isolate further the seasonal and meteorological parameters. If there

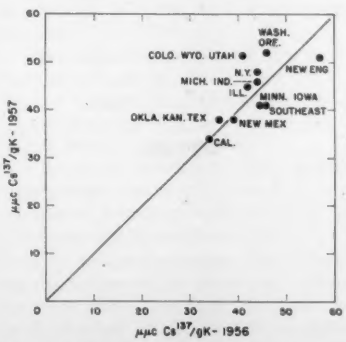


Fig. 7. Levels of cesium-137 in human beings (1956 versus 1957).

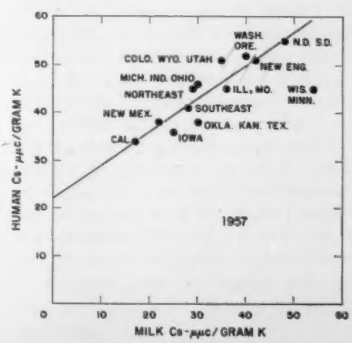


Fig. 8. Levels of cesium-137 in human beings versus levels in milk (1957).

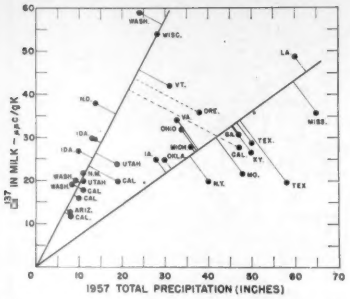


Fig. 9. Cesium in milk versus total precipitation (1957).

should be a cessation of weapon testing, resulting in an uncontaminated troposphere for a few years, one can expect to arrive at definitive data on the rate of stratospheric fallout.

As more conservative calculations are proposed for possible long-term, low-frequency genetic effects, the importance of cesium-137 relative to strontium-90 in fallout is increasing. It is, therefore, more necessary than ever that adequate information on the present levels and their rate of change be available for cesium-137. In addition, the greater facility and economy with which the cesium and potassium determinations can be carried out argue for their greater use in the study of the strontium-90 problem.

Low-level monitoring systems with capacities of tens of thousands of samples per year will also be of the greatest importance in connection with the rapidly expanding power reactor programs. The British experience with contaminated milk after the Windscale incident emphasized the importance of an alert, functioning system for emergency action. However, even in the absence of accidents, the administration of the permissible exposure levels requires detailed radiation studies in the vicinity of all reactors, both before and during operation, and sensitivity levels far enough below the maximum permissible concentrations of activity to give adequate advance warning of possible danger. The psychological value of the reassurance provided the public by continued, detailed monitoring at the natural radiation levels may be as valuable in the long run as the use of the system to provide evidence for or against possible contamination in legal action involving third-party liability. The routine operation of the "Los Alamos human counter" for the past two years is evidence of the practicality of such systems.

## Summary

The routine determination of cesium-137 and potassium-40 content of over 2200 samples was accomplished through utilization of one-fifth of the potential capacity of the Los Alamos human counter. Little change in the cesium-137 concentration in people was observed from 1956 to 1957, in spite of the increase in both the rate and the integrated levels of fallout. The correlation of levels in human beings with cesium levels in milk indicates a discrimination factor of 1.8 in this step of the ecological transfer. Precipitation is shown to be an important factor determining the cesium content of milk, but the lack of complete correlation indicates that a more detailed analysis is necessary. Contamination of the troposphere during periods of weapon testing complicates the interpretation, as do seasonal variations.

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1. E. C. Anderson, R. L. Schuch, W. R. Fisher, W. Langham, *Science* 125, 1273 (1957).
2. E. C. Anderson, *IRE Trans. on Nuclear Sci. NS-3*, 96 (1956).
3. This work was performed under the auspices of the U.S. Atomic Energy Commission. The data here presented are attributable in large part to the skillful and conscientious efforts of Mrs. B. E. Clinton, who ran many of the samples and performed all the calculations. R. L. Schuch assisted in all phases of the program, and J. L. Shields was responsible for the milk counting. F. C. V. Worman assisted in the analysis of the data, and H. E. Gilbert and W. R. Fisher were responsible for the machine programming. My colleagues and I are grateful to R. P. Choi of the American Dry Milk Institute and to J. W. Ballow for their help in obtaining samples. M. A. Van Dilla determined the gamma spectra of a number of samples as proof of radiochemical purity. We are indebted to T. L. Shipman and W. H. Langham for helpful discussions and generous support.
4. U.S. Atomic Energy Commission, New York Operations Office, Health and Safety Laboratory Rept. *HASL-42* (1958) (available from the Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C.). The data are also available on IBM cards from me.
5. E. C. Anderson and M. A. Van Dilla, paper presented at the Scintillation Counter Symposium, Washington, D.C., 1958.
6. E. C. Anderson, R. L. Schuch, W. R. Fisher, M. A. Van Dilla, *Science* 127, 283 (1958)
7. M. A. Van Dilla and E. L. Johnson, unpublished data.
8. The average in Fig. 4 (as well as other figures) should be raised by 2.5 percent to compensate for decay of the standard. The difference is significant only on the relative scale, since the absolute calibration is uncertain by perhaps 15 percent.
9. W. F. Libby, paper presented to the Swiss Academy of Medical Sciences' Symposium on the Noxious Effects of Low-Level Radiation, Lausanne, Switzerland (27–29 Mar. 1958).
10. K. T. Woodward *et al.*, *Proc. Health Phys. Soc.* 79 (1956); C. R. Richmond, thesis, University of New Mexico, and *Los Alamos Sci. Lab. Rept. No. LA-2207* (1958).
11. W. H. Langham and E. C. Anderson, paper presented at the Swiss Academy of Medical Sciences' Symposium on the Noxious Effects of Low-Level Radiation, Lausanne, Switzerland (27–29 Mar. 1958).
12. C. E. Miller and L. D. Marinelli, *Argonne Natl. Lab. Rept. No. ANL-5755* (1957), p. 49.
13. We are indebted to Lester Machta of the U.S. Weather Bureau for a compilation of 1957 precipitation statistics for our milk sampling areas.
14. L. Machta, paper presented at Symposium on Low-Level Irradiation, AAAS meeting, Indianapolis. Ind. (1957).
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# News of Science

## Development of International Efforts to Avoid Contamination of Extraterrestrial Bodies.

This month marks the first anniversary of man's initial step into space. On 4 October 1957, the Soviet Union, acting as a participant in the International Geophysical Year, placed the world's first artificial satellite into orbit. The repercussions of this launching and those that followed have been of the greatest significance in international relations, in education, and in science. A major scientific problem that came into being with the first satellite is that concerned with the contamination of celestial bodies by exploratory devices sent from the earth. It can be assumed that these bodies will be reached in the course of time. The problem that world scientists face is this: how to explore, and yet preserve for study, the physical and chemical structures that obtain on the moon, in the first case, and, eventually, on the other celestial bodies.

### NAS Resolution

The first major scientific body to give thought to this problem was the National Academy of Sciences of the United States. On 8 February 1958 the Council of the Academy adopted the following resolution:

The launching of IGY satellites has opened space to exploration. Accordingly, attempts to reach the moon and planets can be anticipated, with reasonable confidence, within the foreseeable future.

The National Academy of Sciences of the United States of America urges that scientists plan lunar and planetary studies with great care and deep concern so that initial operations do not compromise and make impossible forever after critical scientific experiments. For example, biological or radioactive contamination of extraterrestrial objects could easily occur unless initial space activities be carefully planned and conducted with extreme care.

The National Academy of Sciences will endeavor to plan lunar or planetary experiments in which the Academy participates so as to prevent contamination of celestial objects in a way that would impair the unique and powerful scientific opportunities that might be realized in subsequent scientific exploration.

The Council of the National Academy of Sciences of the United States of America urges the Internaitonal Council of Scientific Unions to encourage and assist the evaluation of possibilities of such contamination and the development of means for its prevention. The Council of the Academy also requests the International Council of Scientific Unions to do whatever else it may to preserve and foster the unaffected potentialities of space research.

### Committee on Contamination by Extraterrestrial Exploration

The International Council of Scientific Unions responded to the Academy of Sciences' request by establishing a Committee on Contamination by Extraterrestrial Exploration. This group, also known as CETEX, met at The Hague 12–13 May 1958, with the following scientists as participants: Marcel Florkin, president; J. Rösch, of the International Astronomical Union; P. Alexander, of the International Union of Biological Sciences; Donald J. Hughes, of the International Union of Pure and Applied Physics. M. Nicolet, of the Special Committee for the International Geophysical Year, and P. Swings, of the International Astronautical Federation Exploratory Committee of the International Council of Scientific Unions, were observers.

The committee considered the problem brought up by the National Academy, and issued the following summary record of the meeting, which is, in effect, a fact sheet on the problem.

*The moon's atmosphere.* The moon's atmosphere contains only a small amount of matter (estimates range from 10 to 100 tons) and is therefore extremely vulnerable to contamination. The release on the surface of any amount of volatile material within this range of magnitude such as might be given off from explosions of TNT for marking purposes is likely to alter the atmosphere for very long periods as it will probably take some years for the products to escape from the moon's atmosphere. Another factor which a change in the lunar atmosphere might bring about is an upset in the thermal equilibrium and careful computation will be required before the magnitude of this effect can be assessed. The possibility that the impact of a rocket vehicle may already be sufficient to alter the atmosphere by releasing trapped gases was rejected because the moon's surface must occasionally be subject to bombardment by heavy meteorites.

The release of any chemical marker on the moon's surface is therefore objectionable if it involves tons of material, and if it has to be done, a flare releasing material quite unlike that normally present in the lunar atmosphere should be used so that in subsequent investigations it can be clearly recognized as a contaminant introduced by man. Both in this connection and because of increased ease in detection a flare produced by burning metallic sodium in chlorine or bromine should be considered. The sodium D lines could be detected at low intensities if a monochromator is used to cut out scattered light of other wavelengths. Probably the quantity of material required to be visible through a telescope, though not to the naked eye, would be insufficient to cause serious contamination of the atmosphere. Even so this type of flare cannot be accepted until the possibility has been ruled out that the ionization of the sodium atoms by releasing electrons would not disturb the "lunar ionosphere" which may be more susceptible than the lunar atmosphere.

Finally the moon's atmosphere will almost certainly be spoilt once measuring instruments are landed, since this requires deceleration which in the present state of the art would involve the release of chemical propellants in ton amounts.

From the foregoing it is clear that detailed exploration can very easily spoil the lunar atmosphere which should, if at all possible, be studied in the initial phases by objects which circuit the moon. Priority should be given to such studies and the committee urges that no flares be lit until information about the atmosphere has been obtained, or until it has been shown that an orbit sufficiently close to the moon cannot be attained. An accidental hit by a vehicle which has failed to orbit would probably not be serious, since the moon's surface must occasionally be subject to bombardment by heavy meteorites and the release of trapped gases by impact will not therefore cause a departure from natural conditions.

*Moon dust.* The chemical composition of the dust on the moon's surface is of

the greatest interest to a wide range of sciences. Knowledge of changes of composition at different levels would also be informative but may be impossible to obtain since bombardment by meteorites is likely to keep the dust mixed. Disturbance of the dust by rocket impact is unlikely to be harmful, as in view of the low density of the lunar atmosphere the disturbed dust particles will fall out locally and not travel all over the moon. For the same reason any contamination of the dust by space operations will be localized and will not prejudice future analytical work (but see the section "Development of complex molecules" below), so long as no fusion or fission explosions are carried out.

The only serious danger of spoiling the moon's dust will come from nuclear explosions. These will release volatile fission products (in the extreme vacuum of the moon even elements like strontium are likely to behave as gases) which will enter the moon's atmosphere and will be rapidly distributed by diffusion. These radioactive atoms will be in a highly reactive form and on coming into contact with moon dust may form involatile compounds. In this way the whole surface of the moon may acquire additional radioactivity which may interfere with subsequent radiochemical analyses that could be of the greatest value in particular for problems relating to the past history of the moon.

In this respect the explosion of a fusion device is likely to be more serious than that of a fission bomb since the former will give rise exclusively to volatile radioactive products, notably tritium, whereas the bulk of the volatile fission products are rare gases which will not combine with the moon dust. However the range of the small particles by which fission bomb activity is spread is likely to be very great on the moon and a serious danger of contamination would undoubtedly arise.

*Cosmic dust.* The possibility that valuable information concerning cosmic (i.e., interstellar and interplanetary) dust may be lost by disturbing the moon's surface has been considered but is unlikely to be serious. This interesting material is known to consist largely of low atomic number elements such as hydrogen, carbon, nitrogen and oxygen and many of the corresponding molecules will be volatilized by solar radiation. Hence only residues of high atomic elements will remain on the moon and this material is no more informative than similar deposits of interplanetary material which can be found at the bottom of the oceans.

*Panspermia hypothesis.* The suggestion that moon dust might help in evaluating the hypothesis that dissemination of life in the cosmos occurred by transport of forms of life in the cosmic dust must be rejected for the same reason as that given in the section on "Cosmic dust" above—namely that solar radiation (in high vacuum) would decompose "biospores" just as it decomposes cosmic dust. Contamination by organic or living matter would therefore not be harmful in this connection although it must be avoided for another reason (see below).

*Contamination of the moon by living cells.* There is no possibility that the introduction of cells such as spores or bacteria might give rise to life on the moon of the same type (i.e., containing deoxyribonucleic acid) as on earth which might confuse later investigators. There are no cells on earth which grow or multiply in the absence of water and at the high vacuum of the moon no water can exist.

*Development of complex molecules.* The basic problem concerning the origin of life is how complex molecules (on the earth they are based on carbon) came to be built up and become replicated. It is conceivable that the interior of the moon dust may provide some valuable clues in this direction. It is not beyond the bounds of possibility that some "prelife" processes may be occurring on the moon and these may be similar to or different from those which had taken place on earth. If there are such processes then the introduction of "foreign" macromolecules from the earth may cause a serious upset in the lunar processes. The earth macromolecules may under lunar conditions act as templates and provide new foci for "prelife" growth. If such events were started indiscriminately all over the moon the pattern might be distorted. It is important to emphasize that living cells are not envisaged for this process and that in this connection a dead bacterium from an aseptic rocket would be as harmful as a live one. Admittedly the occurrence of any such growth reactions is remote but the problem is so important that we recommend that a simple precaution against endangering future studies is to limit the areas of landings on the moon and thereby to localize the effects—if any—of terrestrial templates.

*Contamination of Mars and Venus.* The problems of reaching the planets are of the same kind as those involved in lunar exploration and objects will no doubt be sent there relatively quickly after the moon has been reached initially by circumnavigation, if our findings under the section "The moon's atmosphere" above are heeded. The danger of contamination of these planets is mainly biological since there is a reasonable probability that the conditions on Mars are such that some terrestrial organisms might grow. Water, nitrogen, carbon oxides and light for photosynthesis are all available.

It is therefore of the greatest importance that space vehicles should not land either accidentally or deliberately on Mars (and possibly also Venus) unless all precautions have been taken to exclude living organisms from them. Otherwise the most challenging of all planetary studies, that of extraterrestrial life, may be put in jeopardy. The same precautions in regard to the development of complex molecules which have been dealt with in respect to lunar contamination in the paragraph above apply equally to both Mars and Venus.

Although the relative extent of the contamination from a nuclear explosion would be very much smaller than in the case of the moon it may nonetheless be sufficient to interfere with detailed radiochemical analyses under certain conditions. Also the effect of introducing radioactivity on another planet where there may be entirely differetnt levels of background radiation from those found on earth could greatly influence any form of life found there. Although the objections against nuclear explosions on Mars and Venus may not be as compelling as in the case of the moon, they are nevertheless well justified until more information is available.

### Recommendations

During the first days of this month the eighth General Assembly of the International Council of Scientific Unions met in Washington, D.C. Under its aegis, the recommendations of the CETEX members were made public. They are as follows:

CETEX believes that there is a real danger that exploration attempts made within the next few years may produce contamination of extraterrestrial bodies which would complicate or render impossible more detailed studies, when the technological problems of landing sensitive scientific instruments on the moon and planets have been solved.

CETEX is only concerned with genuine exploration intended to provide bona fide scientific data. Here there may be a conflict, because an experiment essential for one purpose may make it impossible for other types of studies to be made subsequently (e.g., the explosion of a nuclear device to provide seismic data on the interior of the moon or of the planets might make subsequent radiochemical analysis meaningless).

CETEX has considered various dangers of contamination in outline, but did not have at its disposal sufficient scientific and technological data to enable it to propose a specific code of conduct, which should achieve a reasonable compromise between the perfectly proper ambition to start lunar—and possible planetary—exploration at the earliest moment and the need to safeguard future research.

CETEX feels that such a code of conduct must be drafted with the minimum

of delay. It proposes to the ICSU that interested and expert parties be asked by the national members of ICSU to prepare detailed papers bearing on the topics raised in this initial report; and that thereafter these papers be made available to it for a second meeting before the end of 1958, at which detailed recommendations can be prepared with the aid of advisory experts.

## Nuclear Explosion Detector

During this month a new type of seismograph, believed to be capable of detecting nuclear blasts anywhere in the world, will receive intensive tests to determine its effectiveness. The device is the long-period seismograph, capable of recording shock waves with an interval, or period, of a minute or more.

An effort is being made to install as many of the new instruments as possible before the completion of the current series of nuclear tests in Nevada, 31 Oct. To aid in the testing of the new device, the Atomic Energy Commission has announced the precise times and locations of 15 nuclear explosions. Of ten set off in the Marshall Islands in 1954 and 1956, nine were visible on recordings made at the Lamont Observatory. Of five shots in Nevada last year, three were recorded.

Scientists from East and West, meeting in Geneva, recently agreed that long-range detection of nuclear blasts was feasible. The long-period seismograph may prove to be one of the favored devices for an international monitoring system. The United States has announced it is willing to suspend tests on 31 Oct., provided other powers suspend theirs.

## Multiple Birth Roster

The New York City Department of Health has established a "Multiple Birth Roster." The roster is intended to be a source of information for research workers in genetics, child development, and other fields. The department will cooperate with researchers to supply them with some data which may be helpful to them to initiate genetic studies.

All multiple births involving at least two live infants are included in the roster. All the identifying, demographic, and pregnancy information available on the birth certificate of each infant is punched on a tabulating card. A photostatic copy of the complete record of birth is also in the register, so that details not available on the punched card may be conveniently abstracted. The roster will be kept up-to-date in three respects: adoption of a child, death during the first year of life, and data fed back to the roster by the individual researcher. The roster was initiated as of 1 January 1958 and will be continued indefinitely. At a later date an evaluation will be made to determine whether its usage by researchers warrants its continuation.

Researchers requesting information from the roster will be expected to adhere to such requirements as the department may deem necessary. All requests will be reviewed as to the qualifications of the investigator and the value of the proposed study. Investigators may be asked to allocate clerical staff to assist in selecting the data requested. Facts elicited by home interviews or abstract of records, or both, are to be made available by the researcher to other researchers to avoid duplication of effort.

Formal requests should be submitted to Dr. Harold Jacobziner, Assistant Commissioner for Maternal and Child Health Services, New York City Department of Health, 125 Worth Street, New York 13.

## Princeton Archeologists

A team of archeologists from Princeton University has exhumed a large treasure of artifacts in the Serra Orlando region of Sicily. The team, working for the past four summers near the town of Aidone, has found a number of life-sized human busts, pieces of pottery, a stone offertory box, and many terra cotta figures. Some of the objects date from the sixth century B.C.

Aidone, once a fortified inland Greek settlement known as Morgantina, flourished from 600 to 20 B.C., when it disappeared from the pages of recorded history.

The archeological team's prize discovery, a red figured wine and water vessel, was reconstructed from many shards. Pieced together, it is about 16½ inches in diameter and has a neck decorated with a combat scene between Hercules and the Amazons and a depiction of a symposium.

The excavating project, which is supported by funds from the Bollingen Foundation, the university, and several Princeton alumni, will be resumed next spring.

## NASA Receives Assignments

The new Aeronautics and Space Administration has been assigned a number of projects heretofore controlled by the Department of Defense. For the time being the shift of control will be mainly administrative, with the Defense Department continuing to operate the programs. The programs involved are Project Vanguard, the program for four lunar probes of the Advanced Research Projects Agency, three satellite projects, also formerly under ARPA, and a number of Air Force research projects concerned with nuclear rocket engines, fluorine engines, and a 1-million-pound-thrust, single-chamber engine.

NASA will have control over all space projects that are not primarily military in nature. Funds for nonmilitary projects that had been under the Defense Department have been transferred to the new agency.

## Proposals for International Atomic Energy Agency

An international research program on the peaceful uses of atomic energy, to be supported by the United States, was suggested last month by the chairman of the Atomic Energy Commission. At an international atomic agency conference in Vienna, John A. McCone, of the U.S. Atomic Energy Commission, said that under the program, if it is accepted, the United States would assign specific research projects to the agency. In turn, the agency would hand the projects out on a contract basis to scientific teams throughout the world. Addressing the conference of 400 delegates, McCone said: "My government believes that there exists throughout the world today a wealth of scientific and technical competence which is not being brought fully to bear on the development of the peaceful uses of atomic energy."

## News Briefs

The violent hurricane Helene which hit the North Carolina coast last month carried a balloon-borne radio beacon in its eye for some part of its sweep toward the coast. The beacon, devised by the Weather Bureau for more accurate tracking of such storms, was dropped from an Air Force B-50. It was a test device which carried batteries good for only 24 hours. Signals were heard for at least 2 hours after the drop by a monitoring aircraft.

* * *

On 26 September the Navy fired a full-sized 20-inch Vanguard satellite into space, but a failure, suspected to have occurred in a directional gear box, kept it from going into orbit. It was the seventh launching in the Vanguard program, and the sixth failure. The satellite, weighing 22 pounds, contained a scanning device to measure the distribution of clouds covering the earth.

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It was reported at the Air Force Association's Dallas meeting last month that the Air Force's Thor, an intermediate range ballistic missile, has been selected over the Army's Jupiter to be this country's mass-produced IRBM weapon. It was said that a decision had been reached

to turn out two or possibily three squadrons of Jupiters at the most. All other squadrons of the nuclear armed 1,500-mile range missiles will be Thors. Production of the Jupiter weapon, however, will continue for an indefinite time.

* * *

The Atomic Energy Commission is inviting proposals for the development, design, construction, and operation within the United States, including its territories and possessions, the Canal Zone, and Puerto Rico, of a gas-cooled, graphite-moderated, nuclear power plant of sufficient size to serve as an effective prototype for a future full-scale power plant of similar design. The invitation is extended to individual organizations or groups of organizations representing privately, publicly, or cooperatively owned power groups, and to equipment manufacturers, or others. Proposals must be received by the commission within 60 days from 22 September 1958.

* * *

An x-ray unit that will permit physicians to examine the heart at work on an 8-inch television screen was demonstrated in Washington last month. The unit, called a specialized cardiological table, makes fluoroscopic examination for possible heart diseases easier, faster, and safer. The device, developed after 3 years of research, substantially diminishes the amount of radiation a patient is subjected to. An integral motion picture camera allows more detailed study of the heart after the initial exposure to the x-rays.

* * *

The Smithsonian Institution has announced a new booklet, *Anthropology as a Career,* that describes the major subdivisions of anthropology and offers advice on courses and outside activities for high school and college students who intend to specialize in the subject. The booklet, which was prepared by William G. Sturtevant, may be obtained for 20 cents from the Editorial and Publication Division, Smithsonian Institution, Washington 25, D.C.

* * *

A radar with a 1000-foot dish antenna is being designed by Cornell University scientists. Two sites are being considered for the instrument. One is a limestone sink in Puerto Rico. The other is a similar formation in Texas. The radar unit, which should be completed by the spring of 1961, is to be used to obtain space data which once seemed accessible only to artificial satellites.

* * *

The Public Health Service reports that the number of people in the United States without ready access to general hospitals has dropped from 10 million to 2.8 million since 1948. Even in the most rural areas only a small percentage of the population is now without nearby hospital facilities.

This and other evidence of progress in hospital planning and construction, as well as needs for other types of health facilities, are shown in a new PHS publication, *The Nation's Health Facilities —Ten Years of the Hill-Burton Hospital and Medical Facilities Program, 1946-1956.*

* * *

With the opening of the 1958–59 school year, seven panel trucks left the American Museum of Atomic Energy to begin the fourth year of the Atomic Energy Commission's high-school demonstration program "This Atomic World." This year's schedule will bring the program to 1069 schools in 15 states before the end of the school year.

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The North Carolina Engineering Foundation has announced plans to finance the establishment of seven distinguished professorships in the School of Engineering at North Carolina State College. This will enable the college to provide substantial supplements to the state salary scale for the employment of a core of outstanding engineering educators.

* * *

The captain and 16 engineers of the world's first nuclear-powered merchant ship, the *Savannah,* have begun training for the posts they will assume when their ship makes her maiden voyage early in 1960. The group will study at the Marine Reactor Training School in Lynchburg, Virginia. The Babcock and Wilcox Company, builders of the *Savannah*'s reactor, will conduct the school. The training period, to qualify the engineers to operate the ship's 74,000-watt power plant, will be 15 months in length.

## Scientists in the News

RICHARD COURANT has retired as scientific director of New York University's Institute of Mathematical Sciences and head of the university's mathematics department to become professor emeritus of mathematics and science adviser to the university. Courant joined N.Y.U. from Göttingen University in Germany, where from 1920 to 1933 he was professor of mathematics and director of the Mathematical Institute, at that time a world-recognized center for mathematics. He has been head of the department of mathematics at N.Y.U.'s Graduate School of Arts and Science since 1934, and scientific director of the Institute of Mathematical Sciences, the largest mathematics center in the United States, since its creation in 1953.

In July, for his "outstanding contributions" during and since the war, Courant received the Navy Distinguished Public Service Award. This year Courant also received three honorary doctor-of-science degrees—from New York University, Case Institute of Technology, and the Technische Hochschule in Aachen, Germany. In 1955 the Technische Hochschule in Darmstadt, Germany, conferred the honorary degree of doctor of engineering.

New York University honored Courant earlier with the establishment at the university of the Richard Courant lectureship in mathematical sciences. This was announced last January during a convocation for the eminent mathematician on the occasion of his 70th birthday.

Courant is a member of the Royal Netherlands Academy of Science and Letters, the Academia Nazionale dei Lincei (Rome), the Akademie der Wissenschaften (Göttingen), and the National Academy of Sciences and the American Philosophical Society in the United States.

CEDRIC W. M. WILSON of the department of pharmacology and general therapeutics, University of Liverpool, England, has been awarded a Medical Research Council traveling fellowship for a year to work at the National Heart Institute, Bethesda, Md.

EDWIN M. McMILLAN, Nobel laureate and professor of physics at the University of California, has been appointed director of the university's Radiation Laboratory to succeed the late ERNEST. O. LAWRENCE, Nobel Laureate and inventor of the cyclotron. McMillan, an associate director of the Radiation Laboratory since 1954, is a member of the General Advisory Committee of the Atomic Energy Commission. He and Glenn Seaborg shared the Nobel prize in 1951 for their work on the transuranium elements. McMillan also is the discoverer of the theory of phase stability, which paved the way for present research in ultrahigh energy physics.

WILLIS C. BEASLEY, director of the Biophysics Research Laboratory, Bethesda, Md., and director of the Kinesiology Laboratory, Elizabeth Kenny Institute, Minneapolis, Minn., received the gold medal of the American Congress of Physical Medicine Rehabilitation for his scientific exhibits on "Ontogenetics and Biomechanics of Ankle Plantar Flexion Forces" at the congress' meeting in Philadelphia on 28 August.

ROBERT SIMHA, well know in the high-polymer field, will serve as visiting professor of chemistry at the University of Southern California for the academic year 1958–59.

Three major awards will be presented during the 40th annual meeting of the American Society for Metals, which will take place in Cleveland, Ohio, 27–31 October. ALBERT J. PHILLIPS, vice president and director of research, American Smelting and Refining Company, South Plainfield, N.J., will receive the society's Gold Medal; CRAWFORD H. GREENEWALT, president, E. I. DuPont de Nemours & Company, Wilmington, Del., is to receive the Medal for Advancement of Research; and WILLIAM G. PFANN, physical metallurgist, Bell Telephone Laboratories, Inc., Murray Hill, N.J., will receive the Albert Sauveur Achievement Award.

RALPH H. WETMORE of Harvard University will discuss "Morphogenesis in Plants—A New Approach" as a Sigma Xi national lecturer at a number of colleges and universities during October and November.

OLGA LAKELA, after serving for 26 years as a teacher of biology in schools of North Dakota and Minnesota and for 15 years as professor of botany and curator of the herbarium at Duluth State Teachers College and the Duluth Branch of the University of Minnesota, retired as professor emeritus on 15 June 1958.

The Institute for Cancer Research, Philadelphia, Pa., has announced the formation of a Scientific Advisory Committee that consists of the following men: RENATO DULBECCO, professor of biology, California Institute of Technology; DAVID R. GODDARD, professor of botany and director of the division of biology at the University of Pennsylvania, and professor at the Rockefeller Institute, New York; ALEXANDER HADDOW, professor and director, Chester Beatty Research Institute, London, England; ALBERT L. LEHNINGER, professor and director, department of physiological chemistry, Johns Hopkins School of Medicine; and JONATHAN E. RHOADS, professor of surgery and surgical research, and provost, University of Pennsylvania.

The American Society for Horticultural Science has made the following awards for 1958: Leonard H. Vaughan Award in floriculture, J. P. NITSCH, Cornell University, "Growth Responses of Woody Plants to Photoperiodic Stimuli"; Leonard H. Vaughan Award in vegetable crops, IRVING L. EAKS and LEONARD L. MORRIS, University of California, Davis, "Deterioration of Cucumbers at Chilling and Non-Chilling Temperatures"; Charles G. Woodbury Award in raw products research, E. L. PROEBSTING, JR., G. H. CARTER, D. W. INGALSBE, and A. M. NEUBERT, Washington State College, Pullman, "Relation between Leaf Nitrogen and Canning Quality of Elberta Peaches"; Joseph Harvey Gourly Award, L. P. BATJER, H. D. BILLINGSLEY, M. N. WESTWOOD, and B. L. ROGERS, U.S. Department of Agriculture, Wenatchee, Wash., "Predicting Harvest Size of Apples at Different Times during the Growing Season."

MALCOLM M. RENFREW will return on 11 February 1959 to his alma mater, the University of Idaho, to become professor of chemistry and head of the department of physical sciences. Renfrew, who has been director of research and development for Spencer Kellogg & Sons, Buffalo, N.Y., since 1954, and has served in similar capacities for DuPont and General Mills, will succeed WILLIAM E. CONE as department head. Cone, a member of the faculty for 34 years, will relinquish his administrative duties but will continue as professor of chemistry.

The Leidy Medal of the Academy of Natural Sciences of Philadelphia has been awarded to HERBERT B. HUNGERFORD, professor emeritus of entomology, University of Kansas. The medal, which will be presented at a ceremony in the academy on 23 October, is given every 3 years for "the best publication, exploration, discovery or research in the natural sciences." Hungerford's research has been devoted to the ecology and biology of water insects. He is a world authority on the taxonomy of certain aquatic families.

Vanderbilt University School of Medicine is holding symposia on Nutrition in Internal Medicine and on Medical Education in honor of JOHN B. YOUMANS, 4–5 December.

FRANK A. BEACH, JR., formerly of Yale University, and M. BREWSTER SMITH, formerly of New York University, have joined the faculty of the University of California as professors of psychology. Beach is a specialist in animal behavior and the relation of hormones and the nervous system to behavior. Smith, a social psychologist, has made contributions in the investigation of attitudes and personality.

JOSEPH MIGLIARESE has been named head of the Colgate–Palmolive Company's new Laboratory for Biological Research, which is located adjacent to Rutgers University at New Brunswick, N.J. Migliarese, formerly on the Rutgers staff, has been with Colgate for 3 years.

JOSEPH W. LONDEREE has been appointed research manager of the new glass refractories department in the Ceramic Research Laboratory of Corning Glass Works, Corning, N.Y. He has been a member of the research staff of Corhart Refractories Company, Inc., a wholly owned subsidiary of Corning.

MORRIS E. FRIEDKIN, associate professor of pharmacology at the Washington University School of Medicine, has been appointed professor and chairman of the department of pharmacology at the Tufts University School of Medicine. He will succeed BYRON B. CLARK, who has resigned after 10 years to join a midwestern pharmaceutical firm.

Science Service, Washington, D.C., has announced two new staff appointments. RALPH SEGMAN, formerly science editor of Employee Communications at Eli Lilly and Company, is news editor, succeeding HOWARD SIMONS, on leave in order to accept a Nieman fellowship at Harvard University.

DOROTHY SCHRIVER is executive secretary of Science Clubs of America, a Science Service activity, and she has also been designated coordinator of the National Science Talent Search for the Westinghouse Science Scholarships and Awards, administered by Science Service. Mrs. Schriver has been associated with Science Service since 1941. She succeeds MARGARET PATTERSON, who has resigned.

A. M. RABINER has been named professor emeritus of neurology at the State University of New York Downstate Medical Center in Brooklyn. A member of the center's faculty since 1937 when it was still the Long Island College of Medicine, Rabiner retired as professor and head of the division of neurology on 31 August. On the same date he retired as director of neurology at the Kings County Hospital.

Three British scientists received John Price Wetherill Medals from the Franklin Institute on 15 October "for their basic developments which provided the first useful highpower pulsed microwave magnetron, and which established the fundamental principles upon which all later developments in this field were based." The recipients were JOHN T. RANDALL, Wheatstone professor of physics at the University of London, King's College; HENRY A. H. BOOT, a senior principal scientific officer at the Services Electronics Research Laboratory, Baldock; and JAMES SAYERS, professor of electron physics at the University of Birmingham.

# Book Reviews

**Naven.** A survey of the problems suggested by a composite picture of the culture of a New Guinea tribe drawn from three points of view. Gregory Bateson. Stanford University Press, Stanford, ed. 2, 1958. xix + 312 pp. Illus. + plates. $6.

When *Naven* first appeared, in 1936, it had a mixed reception. Some praised it as a new departure in anthropological method and theory, others damned it as bad ethnography or ridiculed it as pretentious nonsense. Its reissue, in 1958, will probably cause much less stir—not because many of the methods and theoretical matters it deals with are out of fashion but because they are now so fully in fashion and because they are now receiving more systematic and articulate treatment by other authors. I am not well enough informed to know what part *Naven* played in introducing these fashions—Bateson has not been widely quoted or credited—but the fact remains that the book antedated by several years the present popular preoccupation with many of the matters it deals with.

*Naven* is the native name for a ceremonial behavior pattern of the Iatmul people, who live on the Sepik River of New Guinea. *Naven* ceremonies are performed by adults in celebration of achievements of a sister's child—such acts as homicide, the first killing of a food animal, the first planting of a yam, the first beating of a slit gong, and the like. Typically, the celebrants don clothing of the opposite sex and show their respect to nephew or niece by various self-demeaning gestures. The book grows out of Bateson's attempt to explain this behavior pattern in terms of other aspects of Iatmul culture and, in so doing, to experiment with some new ways of thinking about ethnographic data. It is not designed to be a standard ethnographic report. This second edition of the work contains the first-edition text, unchanged and complete, together with a new 22-page postscript.

Discarding the conventional institutional and functional approaches to ethnographic presentation as inadequate, Bateson utilizes the following approaches (some of them new, some of them borrowed):

"1. *Structural* or 'logical' relationships, between the cognitive aspects of the various details of cultural behavior: the cognitive reason for behavior.

"2. *Affective* relationships between details of cultural behavior and the basic or derived emotional needs and desires of the individuals: the affective motivation of details of behavior.

"3. *Ethological* relationships, between the emotional aspects of details of cultural behavior and the emotional emphases of the culture as a whole.

"4. *Eidological* relationships, between the cognitive aspects of details of cultural behavior and the general patterning of the cultural structure.

"5. *Sociological* relationships, between the cultural behavior of individuals and the needs of the group as a whole: the maintenance of solidarity, etc." (pages 29–30).

In addition, the author acknowledges the value of two other approaches, developmental psychology and economics, but omits use of them because of inadequate data.

In his chapters on "Structural relationships" Bateson attempts to account for the personnel and the kinds of transactions involved in a *naven* ceremony as logical manifestations of several general premises implicit in Iatmul culture. In this he specifically makes use of Radcliffe-Brown's principle of *identification* [as exemplified in the latter's article on the "Mother's brother" in the *South African Journal of Science* **20**, 542 (1924)], and although he stretches this kind of reasoning almost beyond the limits of credibility, this part of his analysis is interesting and readable.

In his chapter on the "sociology" of *naven*—that is, on its effects upon the integration of Iatmul society—Bateson shows how the ceremony, occurring as it does between members of separate patrilineages, serves to maintain ties between these types of social units, which might otherwise remain hostilely separate because of the absence of other integrative mechanisms (for instance, centripetal community political hierarchies or repetitive marriages between specific patrilineages). Like the chapters on culture structure, this portion of the book is straightforward, noninnovating, and on the whole plausible.

Next, Bateson plunges into the formulation and exemplification of his concept of ethos, which he defines as "the expression of a culturally standardized system of organization of the instincts and emotions of the individuals" sharing a particular culture (page 118). Fortunately the terms of this definition are vague enough to allow the author wide leeway for his rich characterizations of the contrasting ethoses of Iatmul men and women—here again Bateson's reportorial skill escapes the strait jacket of his methodological experimentation. In fact, so vivid are some of his descriptions of Iatmul behavior that one can forgive him for his efforts (which he himself eventually deplores) to classify ethoses and relate them to Kretschmerian and psychiatric types.

Perhaps the most interesting innovation to come out of Bateson's treatment of ethos in his concept of "schismogenesis" ["a process of differentiation in the norms of individual behavior resulting from cumulative interaction between individuals" (page 175)]. *Complementary* schismogenesis is said to occur when, for example, one person of an interacting pair becomes more and more assertive and the other more and more submissive, while *symmetrical* schismogenesis is manifest in the behavior of two individuals who attempt to outboast one another. Again, Bateson displays much more skill in applying these labels to Iatmul behavior than he does in extending their application to psychiatric patients, culture contact situations, and international armament rivalries—although it must be said that he makes a good case for some similarity among these diverse interactions.

Bateson's final approach to the study of Iatmul culture concerns its *eidos*—that is, a standardization of the *cognitive* aspects of the personality of the individuals sharing the culture (page 220). One aspect of Iatmul *eidos* is said to be the great multiplicity and complexity of its ideas or assumptions, and with this goes the high value placed upon erudition (as opposed to rote memorizing). Other characteristics of Iatmul *eidos* are said to be intellectuality, a love of paradox (a sense of pluralism along with a sense of monism, a sense of *direct* dualism ("that everything has a sibling"), a sense of *diagonal* dualism ("that everything has a symmetrical counterpart"), and patterns of thought which govern the seriation of individuals and groups (for instance, the identity of alternate generations) (page 235).

Bateson was certainly not the first ethnographer to describe cognitive aspects of nonliterate cultures, but he must be given credit for helping to revive this phase of ethnography and for

attempting to relate cognitive with other aspects of culture.

The earlier edition of *Naven* closes with a chapter titled "Epilogue 1936." In it the author describes with disarming honesty and almost masochistic candor his shortcomings as a field ethnographer and his flounderings as an analyst. We are presented with the picture of an inadequately trained young man dumped into an enormously complex culture—not knowing what or how to investigate. Some direction is said to have been provided by a visit from two other ethnographers (Margaret Mead and Reo Fortune) and by a reading of Ruth Benedict's *Patterns of Culture*, but it is reported that the data first began to acquire form and meaning in the author's mind after he left the field and began to read more widely in the social sciences. Quite aside from its other merits and demerits, the book is a fascinating slice of autobiography of a highly intelligent, sensitive, and creative individual whose influence upon his contemporaries would undoubtedly be much greater if he were able to communicate his ideas with a clarity equal to his creativity.

Turning now to the final chapter ("Epilogue 1958"), the only new part of this second edition of *Naven*, one finds the theoretical positions of the book discussed in the light of modern developments in cybernetics and communication theory, fields with which Bateson has been closely associated for many years. In my opinion this epilogue adds little or nothing to the value of the book. It is not particularly useful to learn that those aspects of the *naven* ceremony which serve to keep schismogenesis within controllable limits are analogous to "negative feed-back" mechanisms in machines and organisms. Nor is reference to Russell's theory of logical types quite essential for the fairly simple point the author wishes to elucidate. In fact, this postscript merely serves to emphasize the more irritating features of the original work and to obscure its very substantial merits, I shall continue to assign *Naven* to students of social anthropology—but not because of its theoretical formulations themselves (although some of these are useful), and not because of the analogies it draws between human interaction and self-governing machines (although these are suggestive ideas), and most certainly not as an example of how to present ethnographic data. Rather, I will recommend it as a unique and instructive effort, by a highly intelligent and creative fellow student, to record and make sense of behavior in an exotic society.

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**General Zoology.** Gairdner B. Moment. Houghton Mifflin, Boston, 1958. xii + 632 pp. Illus. $7.50.

**General Zoology.** Claude A. Villee, Warren F. Walker, Jr., Frederick E. Smith. Saunders, Philadelphia, 1958. xix + 877 pp. Illus. $7.50.

In these two volumes, both written by men who have previously published successful texts of general biology at the college level, wide divergence in approach is evident on almost every page. Moment uses the popular two-column format and appeals to the eye-minded with handsomely presented photographs and diagrams in abundance. Villee, Walker, and Smith use a single-column format for an intrinsically logical path through the same material, but with illustrations more compact, diagrammatic, and sometimes a bit crowded. Yet, in total wordage, Moment's book is only slightly shorter.

Moment gets through general considerations of zoology and of chemical and living levels of organization rapidly enough to consider whole organisms by page 42. After full coverage of the Protozoa through Ctenophora (in 80 pages), he digresses at length to take up reproduction, embryology, genetics, and evolution (in 102 pages) and then returns for the rest of the animal phyla—considering the styles of organization in each group, functional anatomy, ecology, and behavior. Further discussion is given to ethology, ecology, and conservation in the final chapters. Moment emphasizes current discoveries (for example *Neopilina* among the mollusks), ends each chapter with a list of review topics, and ends the book with a glossary.

Villee *et al.* may assume a better scientific background for students using their book, since each subject is analyzed from simple to complex, eventually reaching the recognizable organism. General considerations, including such details as the glycolytic cycle, meiosis, extraembryonic membranes, and morphogenesis, occupy the initial 147 pages, and animals, as such, are not introduced until page 148. Each group is handled in relation to a described type, with the frog as the central vertebrate. In consequence, many anatomical and physiological features are given triple consideration: (i) in the introductory material, (ii) in relation to specific phyla, and (iii) in a further discussion, extending for 146 pages, following the conspectus of phyla. Genetics, evolution, ecology, and conservation are discussed in the final chapters. Essay-style examination questions are provided at the end of each chapter, but a glossary was omitted deliberately.

The Moment book stresses the liberal-arts approach for purposes of making a zoological contribution toward a general education; it bids informally for student interest and points to the relationship between methodology, new discoveries, and economic applications. Its taxonomy seems modern, although some may be alarmed to find less familiar names for all insect orders (for example, Coleopteriformes, not Coleoptera).

The text by Villee *et al.* should appeal to the dedicated, technical zoologist for whom the living animal as a going concern means less than the problems involved in its physical and chemical operation. That the Krebs cycle and related phenomena are reached on page 73 (in Moment's book on page 520) is an indication of comparative emphasis.

LORUS J. MILNE
MARGERY MILNE
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**Heat Transfer.** vol. II. Max Jakob. Technical and editorial assistance by Stothe Peter Kezios. Wiley, New York; Chapman & Hall, London, 1957. xxxii + 652 pp. Illus. $15.

In volume I, the author treated the basic equations of heat transfer, thermal properties of matter, heat conduction, convection without phase change, and convection with phase change. In volume II he takes up radiation, applications to thermometry, heat exchangers, regenerators, cooling towers, falling liquid films, transpiration cooling, turbine blade cooling, high-speed boundary layers, liquid metal heat transfer, and packed columns. There are also supplements to volume I.

For each topic the author reviews the available references and calls attention to misprints and errors in early works. Time and again one finds a footnote indicating that in private communication "Mr. X" has furnished the author with the correct derivation or data to replace the material previously published.

The author had considerable experience as an experimentalist, and he devotes much space to suggestions for experimental methods.

It is doubtful that anyone except Max Jakob could have written this book. The treatment of each topic is exhaustive and at a high level. Jakob had an extensive file of references, assembled over half a century of his professional life. The list of references for volume II occupies 19 pages. He was schooled in the European tradition, and his thoroughness is apparent on every page.

A few topics have been omitted: the Oppenheim network method for radiation calculations, new work on noniso-

thermal convection and boiling, and the most recent work on boundary layer flows with dissociation or reactions. With the exception of these topics, all of which came into prominence just at the time of, or after, the author's death, volumes I and II contain essentially all the important fundamental material in the field of heat transfer. These deficiencies are, however, insignificant when one views the total work.

S. P. Kezios has preserved the author's style and intent. We owe him a debt of gratitude for having completed this excellent, up-to-date summary of the science and art of heat transfer. It will take its place in the list of classical treatments which every graduate student must study and master. Max Jakob left us his own monument.

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**The Extra Pharmacopoeia.** Martindale. vol. I. Published by direction of the Council of the Pharmaceutical Society of Great Britain. Pharmaceutical Press, London, ed. 24, 1958 (order from Rittenhouse Book Store, Philadelphia). xxx + 1695 pp. £3 5s.

Although it is not well known in the United States, *The Extra Pharmacopoeia* has served for 75 years as a useful therapeutic commentary on the official *British Pharmacopoeia* and *British Pharmaceutical Codex*. The new 24th edition contains information on well over 20,000 drug preparations. The general arrangement is alphabetical, but drugs are grouped where possible. Thus, for example, under "quinine," other antimalarials are also considered; in this instance the recording of names, doses, toxic effects, antidotes, contraindications, and uses requires about 30 pages. Short two- or three-sentence abstracts from the literature document many of the points.

This useful and handy book deserves much wider acquaintance in America.

WINDSOR CUTTING
*Department of Medical Microbiology,*
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**Organic Colloids.** Bruno Jirgensons. Elsevier, Princeton, 1958 (order from Van Nostrand, Princeton, N.J.). xiv + 655 pp. Illus. $16.95.

The purpose of this book is to give an elementary, general survey of a borderline subject. The treatment is divided into two parts. The first 16 chapters give a cursory account of the physics and physical chemistry involved in preparing and studying organic colloids, together with a modicum of their organic chemistry. Deliberately, many of the physical equations are flatly stated, with little or no attempt made to show how they were derived, but, at the end of each chapter, excellent references to the literature are provided. A laudable feature, which might well be widely emulated, is the footnote on each odd-numbered page which guides the reader to these bibliographies.

The next 18 chapters discuss selected groups of organic colloids, including macromolecular hydrocarbons and vinyl derivatives; linear and cross-linked polymers; various detergents, dyes, lipids, pigments, polysaccharides, proteins, and nucleic acids; and some biochemical topics, such as blood, milk, cells and tissues, and biocolloids in disease. In most instances, the chemical formulas are satisfactory, although double bonds are omitted from benzene rings and the Haworth (perspective) formulas for sugars have been shorn of their perspective (without which they are always misleading and sometimes erroneous).

This is essentially a reference book; it has a complete author index (16 pages) and a general subject index (11 pages). It should prove useful to those neophyte biophysicists and physical chemists who need an up-to-date outline of the relevant organic chemistry; similarly, biochemists and organic chemists will find it a convenient source for the physical chemistry involved in this field. Although it cannot be regarded as a textbook, it could well serve for collateral reading.

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**Mathematical Foundations of Information Theory.** A. I. Khinchin. Translated by R. A. Silverman and M. D. Friedman. Dover, New York, 1957. 120 pp. $1.35.

Dover Publications is to be congratulated on making this translation of two papers by an outstanding Russian authority on probability and statistics available to Westerners unable to hurdle the language barrier. Both papers are largely expository, setting forth the work of Shannon and later results obtained by Feinstein and McMillan, along with some original work. The book is marked by rigor, elegance, and clarity, and the smooth-flowing text betokens an excellent job of translation.

The first paper, "The entropy concept in probability theory," is motivated by the idea that the entropy concept is destined to become a permanent part of probability and statistics and is concerned with its precise formulation and general mathematical properties. This is certainly one of the best places for a mathematically mature reader to get a sound introduction to information theory in a few pages (28).

The second paper, "On the fundamental theorems of information theory," is a masterly presentation of the essential mathematical content of modern information theory, filling logical and mathematical gaps in previously available treatments. While the level is perhaps too difficult for the average engineer, mathematicians, statisticians, theoretical physicists, and information theorists will find the book perhaps the soundest discussion of foundations, and thus the most solid base for further development, available.

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**The Senses.** Wolfgang von Buddenbrock. Translated by Frank Gaynor. University of Michigan Press, Ann Arbor, 1958. (First published as *Die Welt der Sinne*; ed. 2, Springer, 1953.) 167 pp. Illus. $4.

This book is the latest number in the Ann Arbor Science Library. All of the titles that have appeared so far in this series are translations from the well-known German series of brief popularizations, *Verständliche Wissenschaft,* published by Springer-Verlag.

Wolfgang von Buddenbrock is emeritus professor of zoology at the University of Mainz. He has written several books on comparative physiology, including some popularizations.

The book attempts to describe the role of the senses in animal and human behavior, drawing examples from a wide variety of species. The first part takes up general questions concerning all the senses; the second part has individual chapters on eight different senses. In the brief compass of the text there can be no attempt at completeness; material is selected for mention because it is important or because it is intriguing. The presentation is simple, informal, and lively, and the reader who is unacquainted with the field will undoubtedly pick up much information.

Unfortunately, such a reader will pick up many errors as well. One striking case is due to the translation: ". . . we . . . confront the lowest with the highest when we compare the nervous system of an octopus with the inexplorable seat of the soul of man, his brain" (page 34). Here the German referred not to an octopus, which actually has a highly developed nervous system, but to "eines Polypen"—a coelenterate—which has a primitive nerve net. (The reader can de-

cide for himself whether the brain is the inexplorable seat of the soul.)

Most of the inadequacies are found in the German as well as the English version. For example, the author states, "So we perceive the sensation known as 'black' when no light impinges on our eyes" (page 86). It has long been known that black is perceived only through contrast, either spatial or temporal, between more and less brightly illuminated areas. Thus, some illumination is required if black is to be perceived. To give one more example, the author states that it has never been scientifically explained how people can detect obstacles in the dark without physical contact (page 125). Several experimenters have demonstrated that hearing plays the largest part in such performance; thus human beings have some of the ability of the echolocating bats which von Buddenbrock has described a little earlier (page 103).

A useful index has been added in the translation, but there are neither references nor suggestions for further reading.

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**Inorganic Syntheses.** vol. V. Therald Moeller, Ed. McGraw-Hill, New York, 1957. xiv + 265 pp. Illus. $6.

*Inorganic Syntheses,* volume 5, is a worthy addition to this useful series. It contains 63 numbered syntheses, many of them representing several compounds. Four volumes have now appeared since the war, at intervals of from 3 to 4 years, reflecting the continued activity in inorganic chemistry.

The contents reflect current research interests. There are, for example, preparations of several carbonyls and of carrier-free $I^{131}$. Rare-earth chemistry is well represented. A number of broadly useful reagents are found, including $N_2O_4$, HOCl, $Co_2(SO_4)_3 \cdot 18H_2O$, and $BeCl_2$. Some procedures are merely improvements on older ones. There also is a review of polyhalogen complex salts, followed by several preparations.

The subject index and the formula index include complete entries to all volumes in the series. The content of each volume is random because each procedure is volunteered more or less independently of the others, but the cumulative effect leads to comprehensive coverage. For example, four binary phosphorus halides are listed, but not more than two in any one volume. The formula index now contains upwards of 600 compounds, so that the series is approaching the more encyclopedic handbooks published in Germany a number of years ago.

The checking procedure continues to be a valuable feature. The checkers are always independent of the original contributors, their names are published, and frequently their suggestions for improvements are mentioned.

I noted very few obvious errors in reading the text. It is unlikely that serious chemical errors occur, simply because so many hands have been on each procedure. The format seems overly conservative, but it conforms with that of previous volumes and is useful.

This book is highly recommended to any who have need of dependable procedures for preparing inorganic compounds.

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## Miscellaneous Publications

*(Inquiries concerning these publications should be addressed, not to* Science, *but to the publisher or agency sponsoring the publication.)*

*Meteorological Utilization of Images of the Earth's Surface Transmitted from a Satellite Vehicle.* ASTIA-AD-146764. Arnold H. Glaser. 145 pp. *Particle Size Distribution in Rain and Snow Inferred from Z-R Relations.* Meteorol. Radar Studies No. 7. ASTIA-AD-146765. Raymond Wexler. 8 pp. *A System for Recording Eight Meteorological Elements Simultaneously on Moving Film (Weatherlog).* AFCRC-TN-58-227. G. K. Thompson. Meteorol. Radar Studies No. 8. 59 pp. *Vertical Structure of Continuous Streamer-form Precipitation.* AFCRC-TN-58-401. Meteorol. Radar Studies No. 10. Raymond Wexler and David Atlas. Blue Hill Meteorological Observatory, Milton 86, Mass., 1958. 38 pp.

*Study of Synoptic-dynamic Influences on the Nature of Cloud and Precipitation Echoes, October 1953–February 1958.* AFCRC-TR-58244. Meteorol. Radar Studies, Final Report. 36 pp. Blue Hill Meteorological Observatory, Harvard Univ., Milton 86, Mass., 1958.

*Anthropology as a Career.* William C. Sturtevant. 18 pp. *Mississippian Fauna in Northwestern Sonora Mexico.* Misc. Collections, vol. 119, No. 3. W. H. Easton, John E. Sanders, J. Brookes Knight, Arthur K. Miller. 96 pp. *New American Paleozoic Echinoids.* Misc. Collections, vol. 135, No. 9. Porter M. Kier, 26 pp. *A Review of the Copepod Genus* Ridgewayia (Calanoida) *with Descriptions of New Species from the Dry Tortugas, Florida.* Proceedings of the U.S. National Museum, vol. 108. Mildred Stratton Wilson. 42 pp. *The Statistics of Meteors in the Earth's Atmosphere.* Contribs. to Astrophysics, vol. 2, No. 11. Gerald S. Hawkins and Richard B. Southworth. 16 pp. Smithsonian Institution, Washington, 1958.

*The Descent of Satellite 1957 Beta One.* Spec. Rept. No. 15. Optical Satellite Tracking Program. 13 pp. *Position of Satellite 1957 Beta One During the First 100 Revolutions.* Spec. Rept. No. 16. 22 pp. *Reports and Analyses of Satellite Observations.* Spec. Rept. No. 14. 43 pp. Smithsonian Institution, Astrophysical Observatory, Cambridge, Mass., 1958.

*The Self-Glazing Phenomenon Associated with Shales and Clays Containing Small Amounts of Soluble Salts.* Bull. No. 65. James T. Tanner. 21 pp. $1. *A Tensile Impact Test for Plastics.* Bull. No. 67. P. H. McDonald, Jr., and J. A. Edwards, 17 pp. $1. Dept. of Engineering Research, North Carolina State College, Raleigh, 1958.

*Admission Requirements of American Medical Colleges, Including Canada, 1958–59.* Compiled by Helen Hofer Gee and E. Shepley Nourse. Assoc. of American Medical Colleges, Evanston, Ill., 1958. 235 pp. $2.

*Applied Mechanics in Engineering.* An inaugural lecture delivered at University College, London, 23 January 1958. R. E. D. Bishop. Lewis, London, 1958. 24 pp. 2s. 6d.

*Atomic Energy Commission, Twenty-fourth Semiannual Report.* U.S. Atomic Energy Commission, Washington 25, 1958. 410 pp.

*The Advancement of Medical Research and Education Through the Department of Health, Education, and Welfare.* Final report of the Secretary's consultants on medical research and education. Office of the Secretary, Department of Health, Education, and Welfare, Washington, 1958. 82 pp.

*A Bibliography of Avian Mycosis* (partially annotated). Misc. Publ. 631. H. L. Chute and D. C. O'Meara. Maine Agricultural Experiment Station and Lederle Laboratories, Orono, Maine, 1957. 44 pp.

*Bibliography of the Arabian Peninsula.* Eric Macro. Univ. of Miami Press, Coral Gables, Fla., 1958. 94 pp.

*Bibliography on Medical Electronics.* Prepared by Medical Electronics Center of the Rockefeller Institute. Professional Group on Medical Electronics, Inst. of Radio Engineers, New York, 1958. 91 pp. $2.50.

*The Behavioral, Ecological and Morphological Characteristics of Two Populations of Alder Flycatcher,* Empidonax traillii (*Audubon*). Bull. No. 371. Robert Carrington Stein. New York State Museum and Science Service, Albany, 1958. 63 pp.

*The Butterflies of Mississippi.* Studies in Zoology, vol. 6, No. 2. Bryant Mather and Katharine Mather. Tulane Univ., New Orleans, La., 1958. $1. 46 pp.

*Chloroplast Pigments and Chromatographic Analysis.* Thirty-second annual Priestley lectures. Harold H. Strain. Phi Lambda Upsilon and associated departments, Pennsylvania State Univ., University Park, 1958. 180 pp. $2.50.

*Educators Guide to Free Slidefilms.* Mary Foley Horkheimer and John W. Diffor. ed. 10. 205 pp. $6. *Elementary Teachers Guide to Free Curriculum Materials.* Patricia H. Suttles, Ed. ed. 15. 318 pp. $6.50. Educators Progress Service, Randolph, Wis., 1958.

*Forest and Range Influences Publications, 1956–1957.* Personnel of the Forest Service. U.S. Dept. of Agriculture, Washington, 1958. 20 pp.

# Reports

## Mucopolysaccharides of Costal Cartilage

Probably no other connective tissue has been investigated more frequently than hyaline cartilage. From the time of Boedecker in 1854 to the present, this tissue has been used for the preparation of chondroitin sulfate. In recent years it has been used in studies of the native protein complexes of mucopolysaccharides (*1*) and on biosynthesis of the carbon chain and the incorporation of ester sulfate (*2*). Meyer *et al.* have previously reported on the isolation of chondroitin sulfates from bovine tracheal cartilage and costal and sternal cartilage of newborn children (*3*). On the basis of optical rotation and solubility of the Ca salts, the mucopolysaccharide fractions appeared to be mainly A (4-sulfate) with a minor C (6-sulfate) component (*4*).

In this report (*5*), attention is called to the isolation of keratosulfate from costal cartilage in two cases of Marfan's syndrome (for literature, see *6*) and from two 23-year-old males with apparently normal skeletal development.

Costal cartilage was obtained at autopsy from two males age 33 and 44 with typical Marfan's syndrome (*7*) who had died of ruptured aneurysm of the aorta and one 23-year-old male who had died suddenly after operation for removal of a brain tumor. The other died after an overdose of a drug. The cartilage was dissected free of extraneous tissue and of perichondrium and dehydrated in acetone. The air-dried tissue was homogenized in 0.1*N* HCl in a high-speed blender, digested with pepsin at *p*H 1.5 in the presence of toluene followed by tryptic digestion at *p*H 7.5. After deproteinization, the mucopolysaccharide fractions were obtained as calcium salts as described previously (*3*).

The total mucopolysaccharide fractions isolated represented 11 and 12 percent of the dry weight of the cartilage in the two cases of Marfan's syndrome and 16 to 18 percent for the controls (*8*). The former consisted of approximately equal quantities of chondroitin sulfate which was characterized as chondroitin sulfate C by analysis, solubility, and infrared spectra and of keratosulfate which was identical in analysis, rotation, and infrared spectrum with that isolated from bovine cornea (*9*). The hexosamine of the keratosulfate fraction was identified by paper chromatography as glucosamine and isolated from one fraction as the crystalline hydrochloride ($[\alpha]_D$ + 72°), and galactose was identified by paper chromatography, and as the crystalline α-methylphenyl hydrazone by melting point and infrared spectrum. The controls yielded chondroitin sulfate and keratosulfate in a ratio of 2.5 to 1 instead of the 1 to 1 ratios in the Marfan's syndrome (*8*).

Thus far keratosulfate, a polymer of unknown structure composed of equimolar amounts of N-acetyl glucosamine, galactose, and sulfate, had been isolated from bovine cornea (*9*) and nucleus pulposus (*10*) where it constitutes approximately one-half of the total mucopolysaccharides, and from the end pieces of the long bones of calf where it was only 1 percent of the total mucopolysaccharide (*3*). In cornea the other half of the mucopolysaccharides is made up of chondroitin sulfate A and chondroitin, while in nucleus pulposus the remaining half appears to be chondroitin sulfate C. Thus the mucopolysaccharide pattern of the costal cartilage in Marfan's syndrome resembles that of nucleus pulposus.

It appears possible that keratosulfate occurs more widely in connective tissue than believed heretofore and that it has been missed because of the greater alcohol solubility of its salts. The occurrence of glucosamine in articular cartilage has been reported by Kuhn and Leppelmann (*11*), who noted a large decrease in galactosamine and a small increase of glucosamine with increasing age. Similarly Shetlar and Masters (*12*) noted in costal cartilage a large decrease in uronic acid with increasing age, while the total hexosamine increased only slightly. These results were interpreted as indicating an increase of a "neutral mucopolysaccharide" in aging, but are readily explained by the absence of detectable amounts of keratosulfate in costal cartilage of newborn infants and the relatively large amounts found in mature costal cartilage. The indication from the rotation and solubility data that the chondroitin sulfate of the newborn infant costal cartilage was mainly A and of the mature costal cartilage mainly C was verified by the infrared spectra (*4*).

It appears from these data that the mucopolysaccharide pattern of hyaline cartilage is more complex than believed heretofore. The distribution of keratosulfate and of the types of chondroitin sulfate will have to be reinvestigated, with regard to age, species, and the source of the cartilage.

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* Established investigator of the American Heart Association.

13 June 1958

## Possible Role for Vitamin K in Electron Transport

Coupled oxidative phosphorylation in extracts of *Mycobacterium phlei* is dependent on a particulate and a soluble fraction (*1*). In an attempt to elucidate their respective roles, a study of electron-transport pathways in these fractions was undertaken (*2*). The characterization of some of the soluble electron-transport enzymes has been described in an earlier report (*3*).

Cells grown with continuous aeration

*Instructions for preparing reports.* Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

were washed twice with distilled water and disrupted by sonic vibration at 10 kcy/sec for 4 minutes. They were then centrifuged at 20,000 *g* for 30 minutes. The cellular debris was discarded and the supernate, to be referred to as the crude extract, was centrifuged at 140,000 *g* for 90 minutes. This yielded a straw-colored supernate and a red pellet consisting of particles ranging in size from 20 to 180 mμ as previously described (*1, 4*). The supernate was withdrawn carefully and was recentrifuged at 140,000 *g* for 90 minutes to ensure a particle-free preparation. The particles, in the experiments to be described, were washed with 0.1*M* KCl buffered with tris(hydroxymethyl)aminomethane at *p*H 8 and recentrifuged at 140,000 *g* for 90 minutes.

The distribution of activities in the washed particles and recentrifuged supernate are compared in Table 1. As can be seen, the supernate did not catalyze the oxidation of DPNH (reduced diphosphopyridine nucleotide) with $O_2$ or vitamin $K_1$ (2-methyl-3-phytyl-1,4-naphthoquinone) as electron acceptor. However, electron transfer did occur in the presence of FMN (flavin mononucleotide), ferricyanide, menadione (2-methyl-1,4-naphthoquinone), dye (2,6-dichlorophenol indophenol), or mammalian cytochrome *c*. The particulate fraction catalyzed the oxidation of DPNH with $O_2$ as electron acceptor, and the rate was enhanced by ferricyanide or menadione but not by vitamin $K_1$ (the slight inhibition noted was due to the Tween 80 used to disperse the vitamin). The particles also catalyzed the reduction of dye, but not that of added cytochrome *c* or FMN.

It has previously been observed that light at 3600 A abolishes coupled oxidative phosphorylation in extracts of this organism and that activity could be restored by the addition of vitamin $K_1$ (*5*). It therefore was of interest to determine the effect of 3600-A light on the oxidation of DPNH by various electron acceptors in the presence of the supernate and particulate fractions. As can be seen in Table 1 (columns marked "Irradiated"), treatment of the supernate with light had little or no effect on the reduction of dye or cytochrome *c*, or on the oxidation of DPNH by the various electron acceptors. The catalysis of oxidation by the particulate fraction, however, with $O_2$ as electron acceptor, was completely inhibited. Restoration of activity could be partially obtained with ferricyanide or vitamin $K_1$, and fully with menadione. Although not shown, addition of vitamin $K_1$ to the ferricyanide reaction mixture resulted in an oxidation of DPNH equivalent to the sum of either alone. The addition of vitamin $K_1$ to the dye, however, significantly increased the rate of dye reduction. This increased rate was presumably a reflection of the nonenzymatic transfer of electrons from reduced vitamin $K_1$ to dye.

Table 1. Electron transport systems in particles and supernate. The reaction mixtures contained 500 μmole of potassium phosphate, *p*H 7.9, 0.42 μmole of DPNH, 0.5 mg of washed particles or recentrifuged supernate protein, and the electron acceptors as indicated, made up to a total volume of 3 ml with distilled water. Reactions were started with DPNH, and all readings noted at 340 mμ were recorded from 15 seconds to 3 minutes. The 600- and 550-mμ readings were made from zero time. Particles and supernate were irradiated in an ice bath in 1 ml amounts with a Gates Raymaster lamp model B at a distance of approximately 3.5 cm for 30 minutes.

| Electron acceptor and amt. (μmole) | Particles | | | | | | Supernate | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $-\Delta E_{600}$ per 15 sec | | $\Delta E_{550}$ per 2 min | | $-\Delta E_{340}$ per 3 min | | $-\Delta E_{600}$ per 15 sec | | $\Delta E_{550}$ per 2 min | | $-\Delta E_{340}$ per 3 min | |
| | Unirradiated | Irradiated | Unirradiated | Irradiated | Unirradiated | Irradiated | Unirradiated | Irradiated | Unirradiated | Irradiated | Unirradiated | Irradiated |
| Dye (0.09) | 0.140 | 0.059 | | | | | 0.448 | 0.428 | | | | |
| Cytochrome *c* (0.06) | | | 0 | 0 | | | | | 0.193 | 0.174 | | |
| $O_2$ | | | | | 0.513 | 0 | | | | | 0 | 0 |
| FMN (0.03) | | | | | 0.509 | 0 | | | | | 0.196 | 0.186 |
| $K_3FE(CN)_6$ (0.51) | | | | | 0.626 | 0.087 | | | | | 0.466 | 0.499 |
| Menadione (0.51) | | | | | 0.548* | 0.529* | | | | | 0.640* | 0.636* |
| Vitamin $K_1$ (1.2) | | | | | 0.457 | 0.111 | | | | | 0 | 0 |

* These are minimum values, for the initial rate of DPNH oxidation in the first 15 seconds, which was not accounted for, was very rapid.

Evidence that the catalytic oxidation of DPNH, with $O_2$ as electron acceptor, is dependent on the structural integrity of the particles was obtained by sonicating cells for various periods of time and testing the crude 21,000 *g* supernate for activity. With increased time of sonication, the ability to oxidize DPNH was reduced. When these extracts were centrifuged at 140,000 *g* for 90 minutes, most of the activity demonstrated in the crude extract was found in the remaining particles. The slight activity present in the supernate was eliminated by recentrifugation.

Spectroscopic examination of the particles revealed the appearance of the reduced bands of cytochromes *b*, *c*, and *a* after the addition of DPNH. After exposure to light at 3600 A, the addition of DPNH did not cause the appearance of these reduced spectra. On further addition of vitamin $K_1$, however, the reduced bands of cytochromes *c* and *a* appeared strongly and *b* only slightly.

Dicumarol, at a final concentration of $2 \times 10^{-4}M$, inhibited the particulate DPNH oxidase activity by 75 percent. In addition, as can be seen in Table 2, $10^{-3}M$ cyanide inhibited 75.6 percent of the oxidation in the untreated particles, and 81.2 percent of the vitamin $K_1$-restored oxidation in the light-treated particles. In contrast, although menadione and ferricyanide were able to act as electron acceptors, they were not on the cyanide-sensitive pathway of electron transport (Table 2). α-Tocopherol, which has been shown to be on the pathway between cytochromes *b* and *c* in mammalian tissue (*6*), could not replace vitamin $K_1$ in restoring DPNH oxidase activity to light-treated particles.

The already noted incomplete restoration of DPNH oxidase activity of irradiated particles by vitamin $K_1$ probably reflects multiple effects of this treatment. DPNH oxidase activity was also reduced by extracting the particles with iso-octane, according to the procedure of Nason and Lehman (*6*), and the activity could then be completely restored by the addition of vitamin $K_1$.

It is suggested that the catalysis of DPNH oxidation by the particles of *Mycobacterium phlei* proceeds through at least two enzymatic pathways. One, involving vitamin $K_1$, or some related

Table 2. Effect of cyanide on DPNH oxidase activity. The reaction mixtures contained 500 μmole of potassium phosphate, *p*H 7.9, 0.42 μmole of DPNH, 0.5 mg of washed particle protein, and 1.2 μmole of vitamin $K_1$, $K_3Fe(CN)_6$, or menadione made up to a total volume of 3 ml with distilled water. Cyanide was added in a final concentration of $10^{-3}M$. Reactions were started with DPNH. Light treatment was similar to that described in Table 1.

| Addition | DPNH oxidized per 2 min (μmole) | | Inhibition by KCN (%) |
|---|---|---|---|
| | Without KCN | With KCN | |
| | *Untreated particles* | | |
| None | 0.196 | 0.048 | 75.6 |
| | *Light-treated particles* | | |
| None | 0.024 | | |
| Vitamin $K_1$ | 0.085 | 0.016 | 81.2 |
| Menadione | 0.247 | 0.248 | 0 |
| $K_3Fe(CN)_6$ | 0.087 | 0.085 | 2.3 |

compound, proceeds through the *cyanide-sensitive* terminal respiratory pathway. The other, in which menadione or other electron acceptors can function, does not involve the *cyanide-sensitive* pathway, but rather a diaphorase type flavoprotein-catalyzed *cyanide-insensitive* reaction.

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23 May 1958

## Changes in the Perceived Color of Very Bright Stimuli

*Abstract.* When very intense stimuli in the long-wavelength region of the visual spectrum are viewed continuously, they change in hue from red, through yellow, to green. The relation of the time course of these changes to the intensity of the stimulus is reported.

In general, the perceived color of a visual stimulus is a function of its wavelength composition. It is well established, however, that the color of a stimulus of fixed wavelength varies somewhat as the intensity of the stimulus is changed. An extensive study of this phenomenon, the Bezold-Brüke effect, was reported by Purdy (*1*). He found, for example, that both red and yellow-green stimuli appear yellower at 1000 trolands than at 100 trolands. However, yellow stimuli (at about 575 mμ) were found to be "invariant"—that is, no color changes were observed as intensity was varied.

Our observations have shown that when a very intense stimulus in the long-wavelength end of the spectrum is fixated continuously, it appears red at first but rapidly changes to yellow and then to a deep, rich green. Intense yellow stimuli, at the wavelength found by Purdy to be "invariant," also turn green. Green stimuli may desaturate but do not turn red. Auerbach and Wald (*2*), while studying the effects of very bright stimuli on subsequent dark adaptation, also noted that intense reds turn green.

We have investigated the time course of these color changes at different wavelengths and light intensities. The observer was presented with a Maxwellian view of a bright, uniformly illuminated, circular field, 15 deg in diameter, with a set of cross hairs for fixation. The source was a 17-ca automobile headlight bulb, run at a color temperature of 2800°K from a direct-current power supply. The effective *f* ratio of the system was 3.0. Heat-absorbing glass protected the eye from excessive infrared radiation. The intensity was varied either by neutral density filters or by a variable on-off ratio flicker vane, run well above fusion frequency. The wavelength composition of the field was controlled by introducing color filters into the collimated part of the optical path.

The subject held three keys. He was instructed to press the first when the stimulus was first turned on, the second when it first turned yellow, and the third when it first turned green (*3*). The keys operated timers, so that the time of each color change was recorded. Each trial consisted of a single presentation of the stimulus at a particular intensity. At least 30 minutes elapsed between trials. For any given color filter, the order of intensity presentations was varied randomly.

In the first experiment a Wrattan No. 29 filter was used. This filter passes all wavelengths longer than about 615 mμ, and none shorter. Four subjects were tested under these conditions, and all showed similar results. The data for one subject are plotted in the upper portion of Fig. 1, which may be interpreted in the following way: At a given intensity —for example, $1 \times 10^5$ trolands—the stimulus was judged red for the first 7 seconds, then yellow for 9 seconds, and then green. No further color changes were observed, even though fixation was maintained for as long as 3 minutes. At lower stimulus intensities the color changes occurred later. For this particular filter, the stimulus remained red indefinitely at intensities below about $0.1 \times 10^5$ trolands. Each point on these curves is a mean of six judgments for one subject. The between-judgments variability for each of the subjects was surprisingly small.

These color changes are not restricted to broad-band stimulation. The red region of the spectrum, as far out as 640 mμ, was explored with a monochromator of 5-mμ spectral slit width, and similar color changes were found.

The lower portion of Fig. 1 shows a curve for a narrow band-pass interference filter at 5.75 mμ. Since this filter appears yellow initially, only the yellow-to-green curve can be plotted. This wave length is one which Purdy reported to be "invariant"—that is, its hue did not change with intensity. However, the highest intensity employed by Purdy was only 2000 trolands, or $0.02 \times 10^5$. At the higher intensities we used, this stimulus turns to a deep, rich green.

Our observations in the green and blue regions of the spectrum failed to reveal changes other than desaturation. Auer-

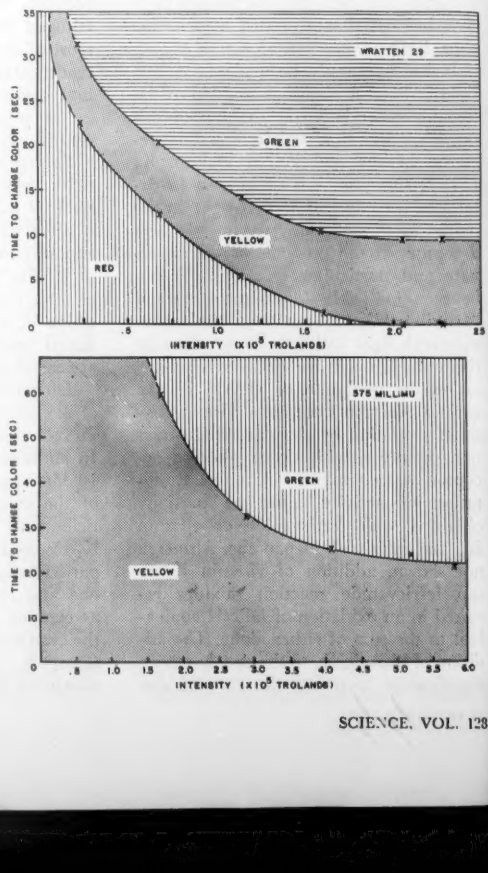


Fig. 1. Time course of changes in hue as a function of the stimulus intensity. The upper plot is for Wratten filter No. 29, the lower, for a narrow band-pass interference filter with a peak at 575 mμ.

bach and Wald (*2*), however, have noted a blue-to-red change, using a Jena BG12 filter. It may be that the particular wavelength composition of the stimulus is more critical in the blue end of the spectrum. Our failure to confirm their observation may thus be a result of our not having that particular filter available.

The described color changes may be accounted for by photochemical adaptation, if it is assumed that there are at least two photopigments in the human retina, a "red" and a "green," with overlapping absorption spectra, and that the rate of regeneration of the "green" pigment is slightly greater than that of the "red." Equations basically derived from this hypothesis yield good qualitative agreement with our data. The verification of the hypothesis, however, must await the results of more extensive experiments.

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3 July 1958

## Low-Temperature Chromatography as a Means for Separating Terpene Hydrocarbons

Recently, a study of the citrus oils was undertaken in this laboratory for the purpose of determining flavor constituents. A gas-chromatographic apparatus was developed for the analysis of terpenes, but it was concluded that preliminary separations were necessary. Kirchner *et al.* (*1*) utilized various forms of silicic-acid chromatography for the separation of terpene hydrocarbons from the oxygenated constituents of citrus oils and for subsequent analysis of the oxygenated fraction. These procedures have been modified and utilized by other workers (*2*). In general, however, silicic-acid chromatography has been unsatisfactory for resolution of terpene hydrocarbons, which may constitute more than 90 percent of a citrus-peel oil.

It was concluded that the gas column would provide an excellent means for monitoring the effluents in a study of liquid-solid chromatographic procedures for separation of the terpenes. Since the results of the above-mentioned workers indicated slight differences in the migratory rates of certain terpene hydrocarbons on silicic acid, columns of various dimensions were prepared for a preliminary study. Synthetic terpene mixtures were then eluted with various organic solvents, and the effluents were analyzed by gas chromatography (as described below) to determine any tendencies toward resolution.

Table 1. Distribution of some terpene hydrocarbons in the effluent from a silicic-acid column.

| Compound | Fraction |
|---|---|
| *p*-Menthane | 3–4 |
| α-Pinene | 10–15 |
| β-Pinene | 16–21 |
| *d*-Limonene | 34–35 |

It was observed that results varied with pretreatment of the silicic acid. Silicic acid which was neither washed nor dried did not retain the hydrocarbons to any appreciable extent, and silicic acid which was dried at 105°C and stored over calcium chloride showed only a slight retentive capacity. Increased retention was observed when the silicic acid was washed free of fines (to facilitate packing), dried several hours at 150°C, and used immediately upon removal from the oven. Even after this process, however, the hydrocarbons moved rapidly and displayed only minor differences in migration rates.

On the assumption that migration would be retarded at lower temperatures, experiments were performed in which the columns were operated at the temperature of Dry Ice (−78.5°C). Results indicate that not only are the terpene hydrocarbons retarded at this temperature but that differential retarding occurs. As a result, complete resolution has been obtained in many instances. The example which follows suggests that the technique should be of considerable value in the study of terpenes, and perhaps in the study of hydrocarbons in general.

A special column was constructed for immersion in a vacuum flask, with details as shown in Fig. 1. Silicic acid (Mallinkrodt, 100-mesh) was washed free of fines by the method of Bulen *et al.* (*3*) and dried at 150°C for 48 hours or more. Approximately 5 g of the acid was cooled over calcium chloride (for from 2 to 3 minutes) and added to 50 ml of petroleum ether. A glass-wool plug was tamped into the lower end of the column, the column was half-filled with petroleum ether, and the silicic-acid slurry was added, to give a column 20 cm long. Pressure from a squeeze bulb was applied to the top of the column until no further packing occurred (a sufficient amount of solvent being added to maintain the level above the silicic acid). The column was then suspended in a bath of Dry Ice in acetone, with the level of the coolant well above that of the packing. After 1 to 2 hours, the terpene mixture (consisting of 30 mg each of *p*-menthane, α-pinene, β-pinene, and limonene in 0.5 ml of petroleum ether) was added to the top of the column, and pressure was applied until the solvent dropped to the level of the silicic acid. A glass-wool plug was inserted just above the packing, the solvent assembly was attached, and elution was started with petroleum ether. A flow rate of approximately 3 ml per hour was maintained, and fractions (2.5 ml) were collected manually. After collection of 30 fractions, the petroleum ether was withdrawn from the top of the column with a hypodermic syringe, and a 1:1 mixture of diethyl ether and petroleum ether was added (for elution of the limonene).

Gas chromatography of the fractions was performed with a laboratory-built instrument, in the construction of which a 10-ft column of Apiezon-L or C-22 firebrick, packed in ¼-in. stainless-steel tubing, was utilized. Helium was used as the carrier gas, and samples were injected by means of a Fisher injection assembly. A four-filament conductivity cell (Gow-Mac No. 9285) served as a detector, and the response was recorded on a 10-mv recorder (Varian G-11).

The procedure was as follows: The solvent was evaporated from each fraction at reduced pressure, and the residue

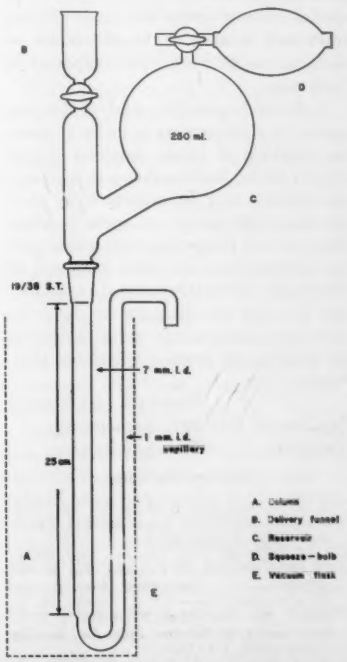


Fig. 1. Assembly for low-temperature chromatography.

was taken up in the injection pipet (0.01 ml). In those instances in which there was insufficient residue, petroleum ether was added to wash traces into the pipet. The sample was injected, with the column temperature maintained at 200°C and with a helium flow rate of 40 ml/min and a chart speed of 5 in. per hour. These conditions do not represent the optimum for resolution but were selected to provide characteristic but short retention times to facilitate rapid analyses.

Table 1 shows the distribution of the hydrocarbons in the effluent from the silica-gel column, as determined by retention times on the gas column. It may be noted that, under the conditions employed, the silicic-acid column provided complete resolution. These results have been verified by a number of replications. In addition, larger samples (0.2 g) have been separated by the same procedure. A mixture (0.15 g) containing 80 percent limonene, 10 percent α-pinene, and 10 percent β-pinene was resolved, indicating that high concentrations of limonene did not interfere with resolution of the more rapid moving components of the mixture.

It is highly improbable that the above-mentioned conditions represent the optimum for separation of the hydrocarbons studied. Moreover, it is quite likely that any procedure will be dictated by the particular mixture to be resolved. It is significant, however, that the pinenes were separated, since they differ only in the position of the double bond. The pronounced retention of limonene is of special interest where the citrus oils are concerned because of the occurrence of high concentrations of this compound in these oils.

It should be possible to adapt the procedure to a preparative scale by employing columns of larger diameter. Upon elution of the hydrocarbons, oxygenated components may be separated by continuation with suitable solvents. In addition, the low temperature should inhibit the chemical changes often observed in adsorption chromatography. In conjunction with gas chromatography the technique may be especially useful, since the gas column can provide additional resolution.

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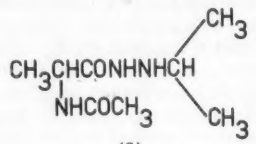
23 May 1958

## Stereospecificity of Monoamine Oxidase Inhibitors

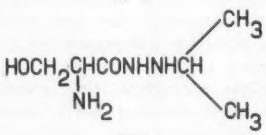
It has been found that isopropyl isonicotinic acid hydrazide (iproniazid, Marsilid) is a potent inhibitor of monoamine oxidase in vitro and in vivo. The alkylhydrazide group seems to be the active principle. Isonicotinic acid hydrazide (isoniazid, Rimifon), a compound similar to iproniazid but not containing the isopropyl group, is only a weak monoamine oxidase inhibitor. Furthermore, according to previous workers and to our own findings, N-isopropylhydrazine inhibits monoamine oxidase more markedly than iproniazid does (*1*).

In order to decrease toxicity and to increase specificity of monoamine oxidase inhibitors in vivo, isopropylhydrazides of substances which occur naturally in the body—for example, the amino acids alanine (acetate)



(I)

and serine



(II)

were synthesized (*2*). It was observed that the derivatives of the *l*-amino acids behaved differently from those of the unnatural *d* isomers.

After administration of the *l* forms of I and II, a considerable increase in 5-hydroxytryptamine (5HT, serotonin) content occurred in the brain of rats, as measured by a spectrophotofluorometric method (*3*). The rise was much more marked than after equimolecular doses of iproniazid. The *d* forms of I and II had significantly less effect on the 5-hydroxytryptamine content of brain than the *l* forms ($p < 0.01$). In fact, with the *d* form of I, no significant increase in 5-hydroxytryptamine could be observed at all (see Table 1).

In vitro, there was also a significant difference between the *d*- and *l*-amino acid hydrazides ($p < 0.01$). However, no correlation could be found between the monoamine oxidase inhibition in vivo (as measured by the rise in 5-hydroxytryptamine in the brain) and in vitro (as measured in mitochondrial suspensions and supernatant). In fact, the *l* forms of I (*4*) and II showed markedly more activity in vivo than iproniazid did. In in vitro studies this was not the case. Thus, the *l* form of I caused significantly less monoamine oxidase inhibition in mitochondrial suspensions and liver supernatant than iproniazid ($p < 0.01$) did. The difference in activity between the *l* form of II and iproniazid was not significant ($p > 0.05$).

These results show that the steric configuration of the acyl moiety is an essential factor in the activity of the above-mentioned isopropylhydrazides on monoamine oxidase in vivo and in vitro. A similar stereochemical difference has been found for amino acid hydrazides without substitution in $N_2$, with respect to action on diamine oxidase preparations (*5*). This stereospecificity may be partly due to the fact that both amine oxidases contain an optically active center, too. The higher relative activity of isopropylhydrazides of natural amino acids, especially *l*-alanine, in vivo as compared to in vitro (see Table 1), is probably due to an additional factor. It

Table 1. Monoamine oxidase inhibition by amino acid hydrazides as compared with iproniazid.

| Inhibitor | Rise of 5HT in rat brain (%) in vivo;* (iproniazid = 100 ±10) | Inhibition of monoamine oxidase (%) in vitro;† (iproniazid = 100 ± 10) | |
|---|---|---|---|
| | | Mitochondria (rat brain) | Supernatant (guinea pig liver) |
| *l*-I | 195 ± 10 | 55 ± 6 | 67 ± 11 |
| *d*-I | 6 ± 4 | 15 ± 8 | 15 ± 11 |
| *l*-II | 200 ± 9 | 142 ± 20 | 106 ± 12 |
| *d*-II | 144 ± 15 | 80 ± 14 | 76 ± 8 |

* Iproniazid in the amount of 100 mg/kg was injected intraperitoneally 16 hr prior to 5HT determination. † Brain and liver were homogenized in 0.25*M* sucrose. The mitochondria were isolated by centrifugation at 500*g* for 5 minutes and subsequently at 23,000*g* for 15 minutes, resuspended in 0.06*M* phosphate buffer (*p*H 7.3), and frozen. The supernatant was diluted 1/1 with 0.1*M* phosphate buffer (*p*H 7.3). The brain mitochondria as well as the liver supernatant were aged for 1½ hours at 37°C. Oxygen consumption was measured, tyramine ($3 \times 10^{-3}$ mole/liter) being used as substrate. Concentration of the inhibitors in the supernatant and of the mitochondrial suspensions were $5 \times 10^{-5}$ and $3.3 \times 10^{-5}$ mole/liter, respectively. At this concentration iproniazid caused monoamine oxidase inhibition of about 50 percent. The enzyme preparations were preincubated with the inhibitors for 15 minutes prior to dipping in the substrate.

is conceivable that naturally occurring substances (for example, *l*-amino acids) have transport mechanisms available in the body which are not present for unnatural compounds. Thus, *l*-amino acids might serve as carriers for the active isopropylhydrazide moiety through natural barriers (such as the blood-brain barrier).

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13 May 1958

## Estimation of Total Body Fat from Roentgenograms

Measurements of the thickness of the subcutaneous fat can be used for estimating man's fatness, and percentile norms for judging the relative fatness of individuals in this way have been provided (*1*). For some purposes, however, an estimate of body fat is desired in absolute rather than in relative terms. Such an absolute estimate can be made with the rather complicated methods of body water and body density measurements. This estimate, in turn, can be used to establish predictions for total fat based on the simpler measurements of subcutaneous fat (*2*). This procedure has proved satisfactory in obtaining estimating equations for total fat from skinfold measurements in young and middle-aged men (*3, 4*).

In the study described in this report the thickness of subcutaneous adipose tissue (plus skin) was measured on soft-tissue roentgenograms, taken at a distance of 72 in. between the tube and the film. No correction for triangular distortion was applied. Data are reported for four sites: (i) upper arm, at the level of the deltoid insertion (see *5*); (ii) upper arm, one-third of the distance between olecranon process and acromion; (iii) forearm; and (iv) calf, at the level of maximal width. All projections were anteroposterior. At site No. 1 the measurements were made vertically to the skin, and at the other three sites they were made vertically to the long axis of the limb. At sites No. 2, 3, and 4 both the lateral and medial thicknesses were measured and summated. Total body fat was estimated from body density, the body volume being obtained by underwater weighing with individual corrections for air remaining in the lungs and respiratory passages at the moment weight was recorded.

Middle-aged business men and professional men, participating in a longitudinal study of aging (*6*), were the subjects. The analysis was restricted to 52 men (mean age 57.1, S.D. = ± 2.7 years) whose weight did not change by more than ± 2 percent from the time of the density measurements to the time when the roentgenographic data were obtained 4 years later.

Equations for predicting body density from roentgenographic measurements and the coefficients of correlation between the two types of criteria of leanness-fatness are given in Table 1. The correlations here recorded must be considered to be slightly depressed from those that would be obtained with measurement of total fat and recording of the x-ray patterns on the same day. But the correlations in Table 1 are in the same general range as those reported when subcutaneous fat was measured with skinfold calipers (*3*). No precise comparison between the x-ray and the skinfold caliper measurements previously made is possible because of differences in the measurement sites.

The number of individuals for whom satisfactory x-ray data were available in all four sites was relatively small. Consequently, no attempt was made to relate body density to roentgenographic measurements in the form of a multiple-regression equation. This is a task for further research in which attention should be given also to some areas on the trunk, including those not readily measurable by skinfold calipers, such as the trochanteric area.

Table 1. Equations ($\hat{D} = a + bX$) for predicting body density from roentgenographic measurements ($X$, in millimeters) and coefficients of correlation ($r$) between density and roentgenographic measurements. $N$ = size of the sample.

| Site | $a$ (intercept) | $b$ (slope) | $r$ | $N$ |
|---|---|---|---|---|
| 1. Deltoid insertion | 1.07220 | −0.00186 | −.60 | 42 |
| 2. Upper arm | 1.07812 | −0.00219 | −.75 | 41 |
| 3. Forearm | 1.07294 | −0.00309 | −.76 | 51 |
| 4. Calf | 1.06447 | −0.00228 | −.58 | 47 |

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7 August 1958

## Effect of Reserpine Pretreatment on Stimulation of the Accelerans Nerve of the Dog

*Abstract.* Pretreatment with two doses of reserpine (each 0.1 mg/kg, intraperitoneally) sensitizes the heart to the positive chronotropic action of norepinephrine and reduces the response to stimulation of the accelerans nerve. Ganglionic transmission remains unaffected. The results indicate that the presence of certain stores of peripheral sympathetic transmitter is essential for the production of tachycardia by stimulation of the accelerans nerve.

Recent experiments (*1*) show that reserpine is capable of causing a tachycardia in the heart-lung preparation of the dog by liberation of norepinephrine from its stores in the heart. Pretreatment of the dogs with reserpine prior to the isolation of the heart, by depletion of the stores of norepinephrine, prevented the positive chronotropic response of the heart-lung preparation to the challenging dose of reserpine. A dose of 0.1 mg/kg injected intraperitoneally 24 hours before the heart-lung preparation was set up was found to suffice for the pretreatment (*2*).

Other experimental evidence indicates that pretreatment with reserpine abolishes the stimulant action of nicotine on isolated rabbit atria (*3*); in this preparation nicotine acts presumably on ganglion cells or chromaffine tissue situated in the heart wall, or on both, and thus liberates sympathin. Reserpine has also been found to reduce the norepinephrine content of sympathetic ganglion cells (*4*).

The experiments described in this report (*5*) were undertaken in order to

study the effect of reserpine-induced depletion of the norepinephrine stores of the heart on the response of the heart rate of stimulation of the accelerans nerve. The ganglion cells of these sympathetic fibers are located in the stellate ganglion and thus differ from the nicotine-sensitive structures of the heart wall. By applying both pre- and postganglionic stimulation, we have tried to establish whether the changes caused by reserpine are fully or partly due to its ganglionic effects (*4*).

The reserpine pretreatment was carried out with two doses of 0.1 mg/kg each, given intraperitoneally 48 and 24 hours prior to the experiment. Fourteen dogs (seven controls and seven pretreated) were anesthetized with 35 mg of sodium pentobarbital per kilogram (some of the pretreated animals required less); the chest was opened, and the preganglionic fibers of the right accelerans nerve were prepared after their central connections had been cut. Electrical stimulation (25 shocks, of 0.7 msec duration, per second) was applied for 10 seconds; the strength of stimulation was increased until a maximal acceleration of the heart beat was obtained. The postganglionic fibers were then prepared at a distance of about 8 mm from the stellate ganglion, and supramaximal stimulation was applied. In order to ensure that the bipolar platinum electrodes were functioning the left vagus was also stimulated. Stimulation of the vagus as well as of the pre- and postganglionic fibers of the right accelerans nerve was repeated after the intravenous injection of 1 mg of atropine sulfate per kilogram, which abolished the response to vagal stimulation. Finally, the response of the heart rate to the intravenous injection of increasing amounts of norepinephrine bitartrate (0.075 to 7.5 μg/kg free base) was determined. The heart rate was read from electrocardiogram tracings recorded with a Grass ink-writing oscillograph.

Pre- or postganglionic stimulation of the accelerans nerve caused pronounced tachycardia in five of the seven control animals, but the response of the heart was rather small in two (C5 and C6) (Table 1). These two animals, however, were found to be relatively insensitive to injections of norepinephrine (Table 2). There was neither a significant difference between the response of the heart rate to pre- and postganglionic stimulation, nor did the administration of atropine cause a significant change in the response of the heart. The mean response of the heart to pre- or postganglionic stimulation of the accelerans nerve (before or after atropine) was equivalent to that caused by the injection of more than 4.9 μg of norepinephrine per kilogram; the reduced response of dogs C3 and C6 to the second period of preganglionic stimulation was probably due to some damage to the nerve fibers.

Six of the pretreated animals were in good condition; only one (R4) suffered from severe diarrhea. The initial heart rate of the reserpine-pretreated animals was significantly lower than that of the controls ($P < 0.001$). The initial blood pressure was also lower, though not significantly; this scatter of results may have been due to the fact that some of the pretreated animals required a smaller dose of sodium pentobarbital.

Pretreatment with reserpine abolished or reduced the response of the heart rate to stimulation of the right accelerans nerve; the difference between the two groups of animals was highly significant ($P < 0.001$). Pretreatment with reserpine did not affect the transmission of maximal impulses through the stellate ganglion, since there was no significant difference between the response of the heart rate to pre- and postganglionic stimulation. Atropine likewise failed to change the response of the heart. Injections of norepinephrine, on the other hand, were found to have an increased action in pretreated animals; the difference between the two groups of animals was highly significant ($P < 0.001$). The increased response of the heart to norepinephrine cannot be fully explained by the lower initial heart rate of the pretreated animals, because these were found to respond to such small doses of norepinephrine as failed to elicit tachycardia in the control animals. Comparison of the positive chronotropic effect of stimulation of the accelerans nerve with that of intravenous injections of norepinephrine shows that, in the pretreated animals, nerve stimulation caused a heart rate increase equivalent to that of an injection of less than 0.18 μg of norepinephrine per kilogram (controls: more than 4.9 μg/kg).

Table 2. Response of the heart to intravenous injections of norepinephrine in normal (C) and reserpine-pretreated (R) dogs after intravenous administration of atropine (1 mg/kg).

| Dog | Increase in heart rate (beats/min) after intravenous administration of norepinephrine (μg/kg) | | | | |
|---|---|---|---|---|---|
| | 0.075 | 0.225 | 0.75 | 2.25 | 7.5 |
| *Normal dogs* | | | | | |
| C2 | 0 | 0 | 8 | 30 | 60 |
| C3 | 0 | 0 | 12 | 48 | 60 |
| C4 | 0 | 0 | 18 | 46 | 72 |
| C5 | 0 | 0 | 0 | 8 | 14 |
| C6 | 0 | 0 | 1 | 7 | 23 |
| C7 | 0 | 11 | 38 | 44 | 83 |
| Mean | 0 | 1.8 | 12.8 | 30.5 | 52.0 |
| *Reserpine-pretreated dogs* | | | | | |
| R2 | 4 | 30 | 52 | 89 | 102 |
| R3 | 2 | 5 | 26 | 69 | 108 |
| R4 | 1 | 12 | 19 | 40 | 90 |
| R5 | 5 | 13 | 32 | 72 | 106 |
| R6 | 4 | 8 | 38 | 80 | 96 |
| R7 | 13 | 32 | 41 | 88 | 111 |
| Mean | 4.8 | 16.7 | 34.7 | 73.0 | 102.2 |
| *P* | | | < 0.001 | | |

Table 1. Response of the heart to nerve stimulation in normal (C) and reserpine-pretreated (R) dogs. *a*, Increase in heart rate (beats per minute); *b*, dose of norepinephrine (micrograms per kilogram, intravenous) causing equivalent increase in heart rate as calculated from Table 2 (with exception of R1 for which other doses of norepinephrine were chosen for the dose-response curve).

| Dog | Before atropine | | | | | | After atropine | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial conditions | | Preganglionic stimulation | | Postganglionic stimulation | | Preganglionic stimulation | | Postganglionic stimulation | |
| | Heart rate (beat/min) | Blood pressure (mm-Hg) | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* |
| *Normal dogs* | | | | | | | | | | |
| C1 | 161 | | | | 78 | | | | | |
| C2 | 148 | 134 | 90 | > 7.5 | 84 | > 7.5 | 69 | > 7.5 | 61 | > 7.5 |
| C3 | 152 | 110 | 84 | > 7.5 | 75 | > 7.5 | 35 | 2.0 | 64 | > 7.5 |
| C4 | 175 | 106 | 108 | > 7.5 | 98 | > 7.5 | 76 | > 7.5 | 73 | > 7.5 |
| C5 | 185 | 150 | 68 | > 7.5 | 51 | > 7.5 | 48 | > 7.5 | 25 | > 7.5 |
| C6 | 149 | 136 | 17 | 5.1 | 29 | > 7.5 | 2 | 0.9 | 20 | 6.1 |
| C7 | 146 | 126 | 65 | 4.7 | 89 | > 7.5 | 55 | 3.9 | 78 | 6.5 |
| Mean | 159.4 | 127.0 | 71.8 | > 6.6 | 72.0 | > 7.5 | 47.5 | > 4.9 | 53.5 | > 7.1 |
| S.E. | ± 5.7 | ± 6.8 | ± 12.7 | | ± 9.1 | | ± 10.9 | | ± 10.1 | |
| *Reserpine-pretreated dogs* | | | | | | | | | | |
| R1 | 100 | | 0 | < 0.08 | 13 | 0.26 | 13 | 0.26 | 22 | 0.46 |
| R2 | 138 | 114 | 10 | 0.10 | 7 | 0.09 | 14 | 0.12 | 16 | 0.14 |
| R3 | 103 | 99 | 3 | 0.12 | 0 | < 0.08 | 1 | < 0.08 | 0 | < 0.08 |
| R4 | 69 | 52 | 2 | 0.09 | 0 | < 0.08 | 2 | 0.09 | 4 | 0.11 |
| R5 | 110 | 104 | 1 | < 0.08 | 2 | < 0.08 | 0 | < 0.08 | 3 | < 0.08 |
| R6 | 122 | 124 | 17 | 0.36 | 20 | 0.38 | 15 | 0.35 | 13 | 0.29 |
| R7 | 118 | 119 | 4 | < 0.08 | 2 | < 0.08 | 4 | < 0.08 | 13 | 0.08 |
| Mean | 108.6 | 102.0 | 5.3 | < 0.13 | 6.3 | < 0.15 | 7.0 | < 0.15 | 10.1 | < 0.18 |
| S.E. | ± 8.2 | ± 10.7 | ± 2.3 | | ± 2.9 | | ± 2.5 | | ± 3.0 | |
| *P* | < 0.001 | > 0.05 | < 0.001 | | < 0.001 | | < 0.01 | | < 0.01 | |

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## Influence of Social Interactions on Learning Rates in Birds

That learning may be influenced by the behavior of an individual's congeners is fairly obvious (*1*). Relatively little evidence exists, however, demonstrating the role of observational learning among animals in their normal environment, though such evidence as there is indicates that imitational behavior may play a major role in the ontogeny of species-specific response patterns (*2*).

Previous work has shown, for example, that the learning of feeding and avoidance responses by greenfinches (*Chloris chloris*) is greatly affected by the presence of a second individual (*3*). While single birds learned a discrimination rapidly, as did birds which had been trained after having been allowed to observe an already trained bird performing, birds which were being trained in the presence of a naive partner required considerably longer. Finally, when well-trained birds observed the performances of untrained partners, their own performances, which had previously been correct, repeatedly fluctuated to random, or nondiscriminatory, levels. Behavioral data suggested that temporary effects such as social facilitation were not involved, but, rather, that the sight of another bird feeding can actually serve as an unconditioned stimulus potent enough to overcome the negatively reenforcing effect of noxious food.

In the experiments described in this report (*4*) the speed with which adult, wild-trapped greenfinches learned to discriminate between a palatable and unpalatable food source was compared for single birds and heterosexual pairs. These birds were housed in wire-mesh aviaries of volume approximately 110 $ft.^3$ and located on the edge of a wood, in conditions approximating the natural habitat of the species. Food and water were available *ad libitum*, and adequate plant cover and perches were provided. In addition, in each cage was placed a sprig of box (*Buxus* sp.) and ivy (*Hedera* sp.) to whose leaves were glued sunflower seeds or sunflower seeds with moist aspirin replacing the kernel. There were six seeds on each sprig, single birds receiving one pair of sprigs (box and ivy), paired birds receiving twice that number. The sprigs were replenished twice daily. For half of the birds the ivy served as the source of the noxious food (aspirin filled seeds); for the other half of it was box. An error was scored as a failure to take a palatable seed or as the seizing of an unpalatable one. The criterion for seizing was the splitting of a seed or its removal. After the first few trials, virtually all errors were due to taking the incorrect seed rather than to failure to feed.

Because weather conditions and day length were known to affect motivation and hence learning speed, the only valid comparisons that can be made are between paired and single birds which were tested simultaneously. The data given in Table 1, when presented in this fashion, show a striking parallel with those achieved in the previous experiments, which were conducted in a more artificial fashion (*3*). In eight instances the single birds, whether male or female, learned with considerably greater rapidity than the paired birds, who, in several instances, failed to learn the discrimination altogether. In the single instances where the pair learned as rapidly as the single control, observations established that only the female was, in fact, responding. In all other pairs, both birds simultaneously participated in the feeding, at least during the observation period.

This interference with discrimination learning in social situations can fail to be maladaptive only among species whose feeding responses are so conservative as to virtually eliminate the likelihood of their feeding on some unsuitable or noxious food. As earlier work has suggested (*3*), the observation of a partner's feeding response is powerful enough a stimulus, even after delays of 24 hours, to overcome previously established avoidance behavior. Presumably this will not be true of species with a more varied diet or a more opportunistic feeding habit than greenfinches. One might also expect a different situation in species which remain in flocks throughout the year. Investigation of these possibilities should be of considerable value in an elucidation of the relation between learning processes and social organization.

Table 1. Number of errors on successive trials for paired and single greenfinches. The differences between paired and single birds were significant ($p = .05$ or less). Trials were discontinued as soon as one group was discriminating with an accuracy of 11 or less errors in three consecutive trials, this number of errors representing a significant level of discrimination ($p = .05$ or less). The errors made by the single bird were doubled, in order to make direct comparisons possible. The minus signs (−) refer to trials on which the birds did not take either palatable or unpalatable seeds.

| Bird | Errors |
|---|---|
| Pair 1 | 12, −, 14, 9, 3, 6* |
| Male 1 | −, −, 6, 0, 2, 0 |
| Pair 2 | 12, 13, 9, 9, 9, 9, 10, 8, 8 |
| Male 2 | 6, 10, 12, 12, 10, 12, 4, 2, 2 |
| Pair 3a | −, −, 9, 6, 7, −, 6, −, 4, 2, 0, 3, 3, 0, 0† |
| Pair 3b | 11, 8, 12, 7, 12, 7, 7, 6, 10, 6, 8, 4, 1, 11, 7 |
| Male 3 | −, −, 16, 2, 12, −, −, −, 4, 2, 4, 0, 4, 0 |
| Pair 4 | 11, 7, 11, 7, 5, 7, 1, 7, 4, 11, 5, 6, 2, 1, 0 |
| Male 4 | −, 12, 6, 4, 0, 2, 2, 0 |
| Pair 5 | −, −, 12, −, 15, 12, 5, 9, 11, 9, 8, 12, 11, 12 |
| Female 5 | 12, 10, 8, 4, 0, 0, 0, 0 |
| Pair 6 | 15, 12, 10, 8, 12, 11, 11, 9 |
| Male 6 | −, 16, 6, 2, 2, 6, 2, 2 |
| Pair 7 | −, −, 12, 11, 8, 11, 7, 14, 12, 8 |
| Female 7 | 10, −, −, 6, 2, 6, 0, 6, 0, 0 |
| Pair 8 | 12, 12, 12, 12, 12, 12, 12, 12 |
| Male 8 | 8, 6, 0, 4, 10, 4, 6, 4 |

* Escaped. † Only the female responded.


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4. This work was done during the tenure of a U.S. Public Health Service postdoctoral fellowship. I am indebted to Drs. W. H. Thorpe and R. A. Hinde for facilities and discussion.


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## On Nucleon-Antinucleon Symmetry in Cosmology

*Abstract.* It has been suggested that cosmological models should embody an initial nucleon-antinucleon symmetry and that the present ratio of nucleons to antinucleons is the result of a statistical fluctuation. Simple arguments are presented for evolutionary models which appear to rule out this possibility in the development of the universe.

Recently Goldhaber (*1*) suggested that a correct cosmological model should exhibit particle-antiparticle conjugation symmetry. Indeed there is at present no reason to believe that the laws of nature underlying the universe should yield a preferential role for either particles or antiparticles. Yet there are reasonable arguments presented by Burbidge and Hoyle (*2*) that certainly our galaxy, and probably the presently observable universe, cannot contain more than one antiparticle in $10^7$ particles.

These arguments are based on the fact that if the concentration of antiparticles relative to particles were as much as $1:10^7$, then particle-antiparticle annihilation would be sufficient to provide the observed kinetic energy in our galaxy as well as the high-energy electrons involved in radio emission by the Crab nebula and other radio sources. Therefore, if symmetry is demanded, one must seek a cosmological model in which a separation of particles and antiparticles was initially effected or is now being effected in such a way as to explain our not finding an equal influence of matter and antimatter in the observable universe.

On these grounds Goldhaber speculates about initial conditions which are symmetrical between matter and antimatter. He asks the question, "Should we simply assume that nucleons and antinucleons were originally created in pairs, that most nucleons and antinucleons later annihilated each other, and that 'our' cosmos is a part of the universe where nucleons prevailed over antinucleons, the result of a very large statistical fluctuation, compensated by an opposite situation elsewhere?" As still another alternative Goldhaber suggested essentially two "separate universes," one of matter, the other of antimatter, the two being derived from a single initial entity comprising the material of the universe and possessing the desired symmetry.

We should like to point out that one can apparently rule out the possibility that the presently observable universe represents a statistical fluctuation in the history of large-scale nucleon-antinucleon annihilation from an initially symmetric state. The arguments were developed in a paper which we wrote in collaboration with J. W. Follin, Jr., (*3*) some years ago and are presented here in somewhat revised form in the hope of achieving greater clarity.

Suppose that the presently observable expanding universe derived from a state early in the universal expansion in which thermodynamic equilibrium prevailed between nucleons and antinucleons. Consider an ensemble of finite co-moving volume elements $V$, containing $N$ each of protons, antiprotons, neutrons, and antineutrons (a total of $4N$ particles per volume element $V$). In order to end up with the largest residual density of matter, we assume that nucleon-antinucleon pair annihilation led first to mesons, which in turn, and later in the universal expansion, led to electron pairs, neutrinos, and radiation, as appropriate. If $\alpha$ be the probability of the reaction leading to mesons, then averaging over the ensemble of finite volume elements should yield $4\alpha N$ as the mean number of particles transmuting to mesons per finite volume element $V$. The standard deviation of the mean number of nuclei transmuting in this ensemble is therefore

$$\sigma = [4\alpha N(1-\alpha)]^{1/2}$$

This standard deviation clearly has a maximum value for $\alpha = 1/2$, namely,

$$\sigma_{max.} = N^{1/2}$$

One might argue then that, at best, in any finite volume element $V$, the excess of nucleons over antinucleons, or the converse, will be of the order of $\sigma_{max.}$—that is, of the order of $N^{1/2}$.

Assume now that the early history of the expanding universe is that which has been proposed previously (*3*) in connection with synthesis of the elements—namely, the result of a quite general extrapolation back in time of a uniformly expanding relativistic medium. In this model it is supposed that at some early time in the expansion of the universe the temperature was of the order of $10^{10}$°K, adequate to support thermodynamic equilibrium among nucleons, antinucleons, and radiation. We ignore other components of the mixture, such as electrons, positrons, neutrinos, and mesons, in these order-of-magnitude arguments. In such a state the number of nucleons and antinucleons should have been of the order of the number of photons. Assuming the radiation field to have been characteristically black-body, one can compute the photon concentration to have been of the order

$$N_\gamma = \left(\frac{kT}{hc}\right)^3 \cong 10^{31}\ \text{cm}^{-3} \text{ at } T = 10^{10}\text{°K}$$

In order to be quite conservative, let us consider volume elements $V$ having initially (that is, at $T = 10^{10}$°K) a radius equal to that of the present visible universe ($\sim 6 \times 10^9$ light-years). The number of photons and therefore the total number of particles was roughly $10^{31} \times 10^{84}$, or $10^{115}$. For this $N$, we obtain $\sigma_{max.} \cong 10^{57}$. In other words, if one considers nucleon-antinucleon evolution from a state of thermodynamic equilibrium at $T = 10^{10}$°K in a volume element as large as the present visible universe, then the maximum excess number of nucleons over antinucleons, or of antinucleons over nucleons, that one might expect from a statistical fluctuation would be of the order of $10^{57}$.

This is an absurdly small result from two viewpoints. On the one hand, even ignoring the subsequent dilution by the universal expansion, this number is no more than the number of nucleons in the solar system, which is also $\sim 10^{57}$. On the other hand, it is also considerably less than the maximum of 1 antiparticle in $10^7$ particles which could presumably be present in the universe as we know it. In our earlier work (*3*) we used this argument to reinforce our supposition that one had to treat nucleon density in the early stages of the universal expansion as a free parameter and not try to compute it on theoretical grounds. We conclude that one cannot explain the present nucleon-antinucleon asymmetry with a simple argument for a statistical fluctuation without further assumptions.

These arguments do not apply to the other of Goldhaber's speculations—that is, the "cosmon"-"anticosmon" universe. This is a symmetrical form of Lemaître's primeval atom hypothesis, which assumes the evolution of the universe from a single particle, a "universon," containing the mass of the entire universe. With Goldhaber's hypothesis one has the required symmetry to begin with but supposes a separation which removes antimatter from our ken. This model may be philosophically satisfying but must be regarded as considerably more speculative than other cosmological models in vogue, for the reason that it is difficult to imagine observational tests of such a hypothesis at the present time.

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30 June 1958

# Meetings

## Seventh Meeting of Nobel Prize Winners in Lindau

In July of 1957, the winners of the Nobel prize in medicine met in Lindau, Germany, for the third time. Among the participants were the following Nobel prizewinners: K. Alder (Cologne), M. Born (Bad Pyrmont), and O. Hahn (Göttingen).

### Uses of Cortisone

In 1950, Philip S. Hench (Mayo Clinic, Rochester, Minn., U.S.A.) was awarded the Nobel prize, together with Kendall and Reichstein, for the discovery of treating rheumatic diseases with cortisone. Unfortunately, this treatment entailed some side effects, which are now subject to further medical research. In his address at Lindau, Hench considered this question.

It has been known since 1948 that cortisone and ACTH can suppress certain inflammations (rheumatic and gouty arthritis, rheumatic fever, and certain other diseases). Although numerous inflammations are modified by the use of cortisone, this drug cannot be rated as a specific for inflammations. During prolonged use of cortisone in the treatment of a disease like rheumatic arthritis, a number of undesirable reactions might occur: activation of internal conditions (either microbial or nonmicrobial) such as tuberculosis or gastric ulcers; increase in susceptibility to an epidemic disease such as influenza; or flare-up of the inflammation which is under hormone treatment. In order to find out more about the development of certain rheumatic and nonrheumatic inflammations, Hench concentrated on cases of relapses in connection with hormone and nonhormone therapy in surgical cases (for example, pregnancy and trauma). Reaction to the withdrawal of any kind of cortisone (in some cases this applies also to ACTH) includes effects connected with the remedy and others connected with the nature of the disease under treatment. Quite often, in cases of rapid change from spontaneous or stimulated overdoses of cortisone in the blood (hypercortisonism) to subnormal amounts of cortisone in the blood (hypocortisonism), certain reactions may occur in susceptible persons. Those are two factors that have to be considered: the sensitivity of the patient and an abrupt hypercortisone transfer.

The factors that provoke reactions need some special consideration, since they are often related to prolonged therapy. Thus, patients, who are susceptible to those factors may be unknowingly exposed and several ordinary diseases might be activated. The most important point in this connection is the fact that not only can these factors produce a reoccurrence and spread of a disease but they can also produce first attacks of these latent diseases. The period of greatest danger for susceptible patients seems to be shortly after the appearance of the first symptoms of rheumatic disease and the intensification of the hypercortisonism. The results may include different kinds of inflammation of the joints as well as of eye, skin, and blood vessel components.

The conclusions drawn by Hench show that patients with gout, rheumatic fever, rheumatic arthritis, psoriasis, and lupus erythematodes seem to react normally to the biochemical stress of abnormally high levels of cortisone in the blood stream. Symptoms in the joints, if not already present, do not appear. If present, they are suppressed as long as the biochemical stress is maintained, either in a natural or a therapeutical way. As soon as the hypercortisone phase decreases and terminates, an acute or subacute joint- or skin inflammation breaks out. This kind of patient seems to adjust very well to the biochemical stress; however, it is extremely difficult to bring him back to his normal status.

### Lung Angiography and Catheterization of the Heart

Twenty-eight years ago, Werner Forssmann (Bad Kreuznach), the second speaker of the first evening, performed on himself the first probing of the heart. He started his experiments shortly after receiving his M.D. degree at the University of Berlin. He introduced a catheter 65 centimeters in length through the vein of the elbow into the ventricle of the heart and thus demonstrated the possibility of examining the heart in a relatively safe way. In his address, Forssmann only casually mentioned his experiment, but the significance of selective lung angiography and of catheterization of the heart for clinics of heart and lung diseases was obvious.

We all know that there is a close relationship between respiration and the circulation of the blood, and we realize that every disease provokes a disturbance of the metabolism, a change in the circulation of the blood and of the respiration. This fact was discovered more than three hundred years ago by William Harvey, who described "the great circulation of the blood," in his book *De Motu Cordis et Sanguinis,* in 1628. There was a long and difficult road ahead through the centuries. In 1710, for the first time, exact research was carried out on the circulation of the blood, and the volume passed per minute was determined. Two centuries later measurements of the arterial blood pressure followed. These experiments and similar ones, performed on animals, enabled research workers to measure the blood pressure and metabolism by exposing the vein of the neck and inserting a tube from there to the right side of the heart.

In 1929, with Forssmann's experiment on himself, a catheter was introduced into the human heart for the first time. However, this method of examination was not given much consideration at first, and it was only in 1941 that Cournand came back to it. He succeeded in passing the catheter through the right side of the heart to the periphery and measured the pressure of the artery of the lung.

A surgeon must have an exact x-ray picture in order to diagnose and plan a successful operation. As early as 1930 good x-ray photographs were obtained in dogs who had been given intravenous injections of contrast media which filled the small blood vessels. Only much later, after a series of difficult experiments, was this method (called angiocardiography) adapted for man. By means of a catheter which is introduced all the way to the heart or to the lung and through which a relatively small amount of a contrast medium (8 to 11 milliliters) is injected into the area which is to be photographed, it was possible to obtain good x-ray pictures, which could be used by the surgeon. Today we are in a position to make x-ray pictures of these organs and to use them for purposes of research, thanks to selective lung angiography. With a small amount of contrast compound it is possible to show, by means of this kind of x-ray technique, the fine structure of the vessels with their ramifications. This method made it possible to introduce the von Euler-Cournand effect into the clinic in 1953. This effect proves that bad circulation within the lung causes a throttling of the connecting vessels. This permits certain conclusions about the healing of

tuberculosis through the pneumothorax method, which is based on the theory that a lung which is at rest or whose volume is diminished is better nourished than another, and that healing is thus accelerated in tuberculosis. On the basis of the von Euler-Cournand effect we are forced to admit that those conclusions are not relevant and thus that the use of the pneumothorax method should be considerably reduced in favor of other treatments. One can summarize the argument in the following way: owing to the disease of the lung parenchyma, less ventilation of the lung takes place. Thus the vessels are narrowed, and this leads to an increase of resistance to the flow of blood. This increase in resistance results in an increase in pressure in the artery of the lung, and this must be transferred to the right side of the heart. Naturally, this increased burden cannot be handled for a long time by the right side of the heart and will gradually result in insufficiency of the heart. This shows clearly the functional and pathological unity of the lung, the blood circulation, and the heart, and one realizes that the selective angiography of the vessels of the lung should not be considered as an isolated topic.

What does the selective angiography mean in cases of heart disease? In the case of mitral stenosis (narrowing of the mitral valve between the left auricle and the left ventricle of the heart) we have a clinical model which shows us what can be accomplished by heart surgery in case of a valve rupture. It is well known that in the case of a stenosis of the mitral valve, the pressure is increased within the lesser circulation; use of the catheter makes this evident. But how shall we know whether this increase in pressure is the result of a functional, reversible narrowing (regulatory adaptation) or whether it is due to a permanent, irreversible narrowing? In the latter case more harm would be done by a valve rupture. This is where the selective angiogram gives the correct picture and shows the prevailing situation to the heart surgeon. This example shows us that, since the introduction of the angiogram into the clinic, it has been possible to determine the need for surgery at a stage when there is the greatest possibility of its being successful, before organic changes have occurred which cannot be treated by means of surgery. As Forssmann expressed it: "These methods brought us a deep insight into the physiological sides of the problem, which up to now were ignored and which will help us considerably in curing human beings. We actually entered an era of studying circulation. The greater circulation has been subject to research for a long time, whereas the lesser circulation has been more or less neglected. One-sided research in medicine can never bring progress, but only retrogression. Only if everything is included do we get the picture as a whole. Medicine, which all of us revere, seems to me like an unexplored work of art which can be seen in different lights and from different angles. Always one can find new beauty in it, and yet it is always the same. Medicine constantly opens up new insights into life and so, sooner or later, this circulatory concept will be replaced by something new, as earlier ideas have been replaced and yet have never become obsolete."

### New Insights in Cancer Research

Wendell M. Stanley (Berkeley, California) discussed in a very broad manner the possible relations between viruses and cancer. The discovery, around the turn of the century, of the first viruses—the tobacco mosaic, the foot-and-mouth, and the yellow-fever viruses—did not stir up too much excitement, and the knowledge in this field did not rouse very much interest in the 1920's. By about 1930 it was possible to determine, with some accuracy, the size of certain viruses (they were found to be smaller than some protein molecules). In 1935 the tobacco-mosaic virus was isolated in crystal form and recognized as a nucleoprotein. It was discovered that this nucleoprotein molecule has a diameter of 15 mμ and a length of 300 mμ and that it possesses the extremely high molecular weight of 50 million. Thus, it is larger than any molecule ever described before, but it was also discovered that it possesses all the qualities of the larger protein molecules which are related to this kind of protein molecule. The same material could be extracted from plants which had the mosaic disease, and thus was discovered a molecule which was able to reproduce itself and to have mutations. It seemed that the difference between living and lifeless substance was not very sharp any more, and this was the beginning of a complete revolution in the ordinary concepts in this field.

Today we know that the gap between 20 and 200 mμ—that is, between the molecules of the chemist and the organisms of the biologist—is closed by the viruses. Some of the larger viruses are larger than several of the known living organisms, whereas other smaller viruses are actually smaller than certain albumin molecules.

For a long time it was believed that animal and human viruses are fundamentally different, since all crytalline viruses that had been discovered were plant viruses. This belief, however, became obsolete when the two Americans, Schwerdt and Schaffer, discovered poliomyelitis viruses, which represent a typical animal or human virus, in *crystalline* form. Since then, at least one more animal or human virus has been observed to be crystalline; this was the Coxsackie virus, which was discovered by the American Mattern. Hundreds of viruses are known, and yet only about one dozen could be isolated in pure form. Stanley thinks it is justifiable to assume that viruses cover the range from small crystallized animal, human, or plant viruses, through intermediate structures consisting of nucleoproteins, lipoids, and hydrocarbons, to those viruses which have the same morphology and composition as the organisms which consist of cells. All these structures are somehow related to each other by their own characteristic property, and they are all able to reproduce themselves.

In 1903 Borell thought that cancer could be the result of the living and reproductive forces established in the virus. In the meantime several laboratories have found evidence of the virus etiology of cancer, and thus it may be expected that viruses will be found to be responsible for most kinds of cancer. Cancer is a problem of growth ("cancer is life against itself," as F. Deich has pointedly said). The fact that, up to now, only two kinds of little-studied, benign tumors in human beings are known to be caused by viruses, and that it has not been seriously assumed that excitants are present in human cancer, does not mean that these are nonexistent and that they are of no etiological significance. It only means that, up to now, efforts to prove the existence of a virus as a causative factor in cancer have been (for one reason or another) without success. The assumption, as a working hypothesis, of a viral etiology in human cancer will cause a significant change in the attitude of many researchers. This is a necessity, if a correct approach and correct experimental planning are to result.

There is no proof that human cancer is infectious, but it is known that viruses that cause tumors can be both filtrable and infectious at times and, at other times, nonfiltrable and noninfectious. Apparently this is connected with the fact that the viruses are very specific and that a certain virus only infects a certain type of cell. Thus, under different conditions it does not appear to be infectious. This explains the difficulty in demonstrating the existence of virus in human cancer. The breeding of normal and malignant cells offers a good approach. Experiments of this kind are carried out in the laboratories at the University of California, Berkeley. The fact that many different kinds of human viruses have been found leads to the conclusion that there must be still undiscovered viruses in a supposedly healthy human being. It is significant that the infection of cancer cells of a certain type with certain viruses causes the destruction of the cancer cells. Due to the mutability of the viruses, it should be pos-

sible, with the help of already known passage techniques, to develop viruses which have no effect on normal cells but which have a special specificity for the destruction of cancer cells. Various laboratories are now working on these problems.

The fact that viruses are able to remain in cells for generations makes a relationship between virus and gene probable. Genes and viruses are carried over from one generation of cells to another. It was found, for example, that genetic factors of one type of *Salmonella* cells can be transmitted through bacteriological viruses to another. Thus it has been supposed that, under certain circumstances, genes act like viruses and vice versa, that viruses can cause cancer, and that they are forms of the transition zone of life, carrying both life and molecular characteristics.

A discovery which was recently made in the laboratories of Stanley by Fraenkel-Conrat changed the situation considerably. It can now definitely be assumed that nucleic acid is the dominating factor in these considerations. Fraenkel-Conrat and, a short time later, the Germans Gierer and Schramm, discovered that after the tobacco mosaic virus is treated in a special way, a specific nucleic acid is found which possesses the characteristics of viruses. It seems to be a fact that a nucleic acid entity of molecular weight about 300,000 contains, within its approximately 1000 nucleotides, the information to allow the production of the same nucleic acid within its host cell, and apparently it is also able to perform the synthesis of its own characteristic and specific protein, by which it is surrounded. These experiments give beautiful proof of a direct relationship between specific nucleic acid and specific protein synthesis, and they make it possible to consider the activity of the virus and gene, including their temporary connection with cancer, in the form of nucleic acid and not as a nucleoprotein. The finding that viruses, genes, and cancer are all directly dependent upon the structure of nucleic acid is considered extremely important. In Stanley's words, "These and similar studies lead you directly to the heart of the whole cancer problem and should be able to bring a solution in this field, which today is quite confused."

Georg von Hevesy (Stockholm), who almost every year gives an outstanding report on his research, talked about cancer anemia. In recent years many scientists have worked on the concentration of hemoglobin in the blood of persons stricken with cancer. Determinations of concentration showed that the hemoglobin concentration in most people with cancer is 20 percent or more below the concentration in healthy people. This phenomenon, however, very often finds compensation in an increase in volume of blood in people stricken with cancer, and thus the total number of red blood corpuscles of patients with cancer equals that of healthy people. The concentration of hemoglobin in the blood depends on the decay and production, per unit of time, of hemoglobin molecules. It is also determined by the number of red blood corpuscles (which contain the hemoglobin) which decay and originate in this same time interval. These quantities can be determined through radioactive labeling of the iron, one of the main constituents of the hemoglobin.

W. M. Stanley, M. Born, W. Forssmann, S. A. Waksman, O. Hahn, K. Alder, G. von Hevesy, P. H. Muller, P. S. Hench, G. Domagk.

Dal Santo, a colleague of von Hevesy, made some experiments in Stockholm on patients suffering from cancer of the uterus. He found that, quite often, red blood corpuscles have a shorter lifetime in a cancer-stricken organism than in a healthy one but that the shorter lifetime is usually compensated for by a faster new growth of red blood corpuscles.

Similar results were obtained in the United States and by Kiderlein in the clinic in Freiburg im Breisgau, with patients who had cancer in other organs. The shortening of the lifetime of the red blood corpuscles in a cancerous organism is due to the presence of one of these attacking agents in the blood and is also due to the beginning of the growth of abnormal red blood corpuscles in the cancer. This can clearly be seen in experiments with animals, performed in Stockholm by von Ehrenstein. He labeled the red corpuscles of several hundred mice with radioactive glycine. The disappearance of the radioactivity from the blood shows the rate of decay of the red corpuscles. If, after the labeling of blood corpuscles, cancer cells were injected into the animals and tumors resulted, it was found that the radioactivity disappeared twice as fast from the blood of these animals as from that of healthy animals. But the cancerous animals had the same amount of hemoglobin as the healthy ones, since the rapid decay of the blood corpuscles was compensated for by a more rapid formation of new cells. This could also be proved by the fact that the marking of the red blood corpuscles occurred only after the formation of a tumor—that is to say, not in a healthy but in a cancerous animal. Four times as much radioactive hemoglobin was formed in the red blood corpuscles of a diseased animal as in those of a healthy animal. This result very clearly shows the rapid formation of red blood corpuscles in cancerous animals. With this kind of experimentation the way is paved for drawing conclusions, from investigation of the blood, about the existent cancer cells and their activity.

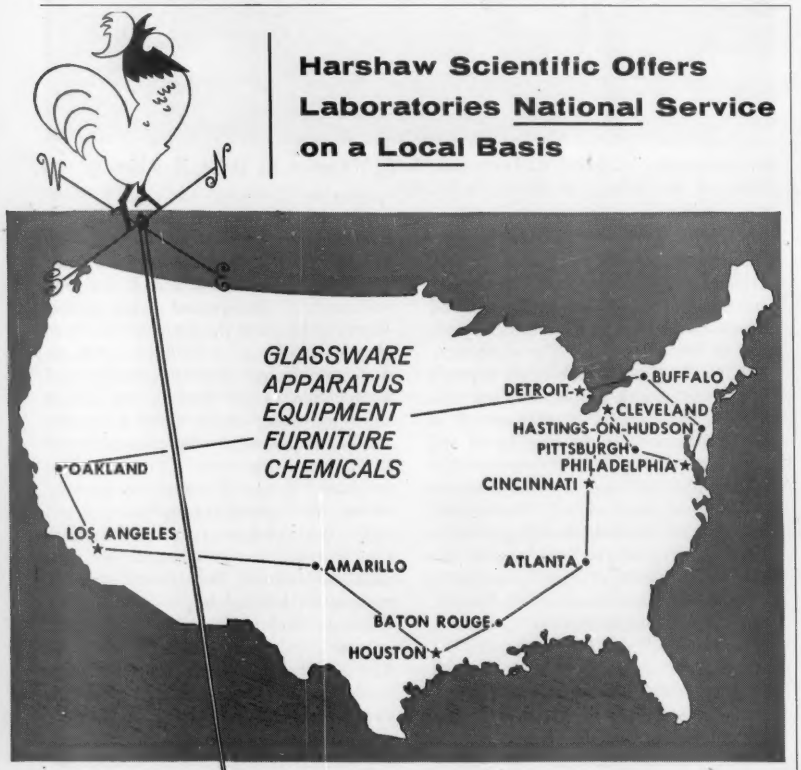
Gerhard Domagk (Wuppertal-Elberfeld), who introduced the sulfonamides into medicine, talked about the chemotherapeutical side of the malignant tumor. The first inhibitor of cell growth (cytostaticum) found, by Otto Warburg, urethane, arrests mitosis in cell tissues. Later on it was observed that urethane not only is cytostatic but also can produce cancer. Other groups, amongst them benzpyrene, were only of passing interest. The cytostatica developed by Domagk brought great relief in the treatment of polycythemia but, on the other hand, also the danger of the formation of new bone tumors. In this ambiguous therapy it is up to the physician to decide whether the patient can be helped

or not by the taking of this medicine. In the 1920's, while doing research on cancerous cells, Warburg found a reduced cellular metabolism, with intensified fermentation. For a long time it was not possible to repeat these experiments in other laboratories, because of the extreme difficulty of the measuring technique, but, through the use of isotopes, these results have been confirmed and carried further. Today we consider tumorous cells to be deteriorated cells, marked by certain morphological structures, and we notice a loss of the mitochondria. This degeneration can also be noticed in the metabolism of these cells through the loss of certain enzyme systems, like respiration ferments. This can be caused through the inhalation of destructive matter or through wrong nutrition during part of the lifetime of an organism, or as a result of other, not yet defined, injuries.

In the last few years it has been possible to combine many single results, and in this way it was found, for instance, that the activity of the cytochrome oxidase and the oxysuccinic acid in sarcomas are only one-fifth those in normal liver cells. A reduction of the catalase content was also noted. The effect of effective cytostatica, like triosephosphate dehydrogenase, for instance, today can be seen in these enzyme systems. Lewisite compounds not only made tumors disappear but also caused tumors, and thus could only be used within limitations. Arsenic and heavy metals (such as lead and gold) are not in great use any more today. But great interest was aroused in the group of the antimetabolites, which include the cytostatica. These were able to prolong the life of leukemia-stricken children by years. Specific and nonspecific albumin therapy in the meantime also brought some success. Cortisone alone or in combination with mercaptopurine showed certain results. Further research is in progress on ways to increase the prophylactic forces in the organism by extracting preparations from tissues immune to tumors. These substances, however, cannot be considered as real cytostatica. The treatment with heterosexual hormones brought good results with carcinoma of the prostate, but there is the fundamental question whether the majority of these tumors can still be considered as genuine cancer. Overdoses, which are quite often given, result in an inverse effect (mammary gland carcinoma). Among the antibiotics there can also be found cytostatic substances, such as actinomycin C and D, which show success with lymphogranulomatosis and Hodgkin's disease. In the meantime new actinomycins have been found, but they have not yet been used in clinics. "That there really are chemotherapeutical drugs to cure cancer has never been stated in any scientific publication, nor has it ever been mentioned in any lecture, only in noncritical newspapers and magazines," stated Domagk.

We can talk about a supplementary chemotherapy of cancer, and in this connection the so-called ethylene iminochinones are of special interest. These substances, belonging to the groups of the cytostatica, not only retard the growth of tumors but also inhibit the growth of normal human, animal, and plant cells. With these substances, the germination of wheat can be stopped. Therefore care must be exercised in administering these drugs in people who are capable of procreation, since these substances are able to change the genes, just like x-rays and other radioactive rays.

These cytostatica can be used only on patients with tumors on which it is too late to operate, and we should be grateful that in this way we are able to prolong the life of the patient under tolerable circumstances. E 39, in the form that is soluble in water, promises a better method of application, as has already been observed on animals which were under constant control for 45 days. It could be confirmed by microscopic examination that tumors of the size of walnuts had decreased considerably. But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# The Motility of Muscle and Cells

*By HANS WEBER.* The experimental data of this study have been arranged in such a way as to show clearly the conditions in the interior of muscles and cells necessary for producing contraction on the one hand and relaxation on the other. The difference between the conditions necessary for the movement of certain organelles of cells and those for muscular contraction and the musclelike contraction of the cells has been shown, giving evidence that Nature invented several very different mechanisms of movement. And an attempt has been made to synthesize the known experimental data on muscular movement and musclelike cell movement into a new theory of contraction. The 1957 Dunham Lectures. Illustrated. $3.50

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one should not be misled by these experiments, since some animals, when under treatment, refuse all food. But during the experiments described above the animals gained weight, which means that E 39 has a "tumor specific" effect.

With surgery we try to eliminate the tumorous cells as completely as possible, but success is very rare, especially when one considers the metastases. Good results are also obtained by means of radiation therapy, but in this treatment one must consider that radiation therapy also destroys the natural prophylactic forces of the body. Therefore the smallest dose possible is applied in therapy for malignant tumors, and one has to be extremely careful to hit the tumorous cells only. By now it is very well known which tumors are best removed through surgery and which ones should be exposed to radiation therapy. Chemotherapy is applied only to tumors which can neither be removed through surgery nor treated with irradiation, and so the chemotherapy has by far the most difficult task to accomplish. It therefore cannot be expected that all treatments of malignant tumors by chemotherapy can be successful. Lately, intravenous injections of ethylenimine compounds have been rather successful. Whether the climate of the North Sea has something to do with the success of these treatments is hard to determine. Research is being done on these questions at the University Clinic for Throat, Nose, and Ear in Münster in Westfalen, Germany.

It must be understood that a body stricken with cancer generally is a weakened organism, a fact which is also to be taken into account in regular treatments. The individual thus stricken should seek rest and a suitable climate for the chemotherapeutical, surgical, and radiation treatments. These requirements are even more important for the cancer patient than they are for the tuberculosis patient. We know from experience that in a case of oxygen deficiency—that is to say, in a poorly aired room—animal tumors grow faster than in the climate of the North Sea. The living conditions of people in big cities become more and more unnatural as a result of exhaust fumes, dust, and so forth, and thus the number of cases of cancer will steadily increase. To quote Domagk: "In therapy we will have to be satisfied, for the present at least, with a certain equilibrium between body cell and tumorous cell, even if the tumor cannot be completely eliminated. We will be satisfied if we can slow down its growth, in order to preserve the life of the patient longer and under bearable conditions. In this case too, we have to learn to think more physiologically and less naively. The chemotherapy of cancer still is in its very beginning and will have to be further extended. The observations we have collected to the present day show that not only leukemia but also carcinomas and sarcomas can be influenced through cytostatica. This seems to be the most important result for the further development of the therapy. The results of these experiments can be related to the treatment of different malignant tumors in man, at least in principle, and this is decisive for further experiments."

### Antibiotics

"The influence of antibiotics on human society has been so tremendous that one was almost tempted to call the present era the age of the antibiotics instead of the atomic age." With these words, Selman A. Waksman (New Brunswick, N.J., U.S.A.), started his talk on the social significance of the antibiotics. This scientist, who was awarded the Nobel prize for physiology and medicine in 1952, is the discoverer of streptomycin, which has shown good results in the treatment of tuberculosis in particular.

Through the progress of practical medicine and public health efforts, the life expectancy of man, which was about 30 years in the 18th century, has been increased to about 70 years. If medicine continues to develop at the


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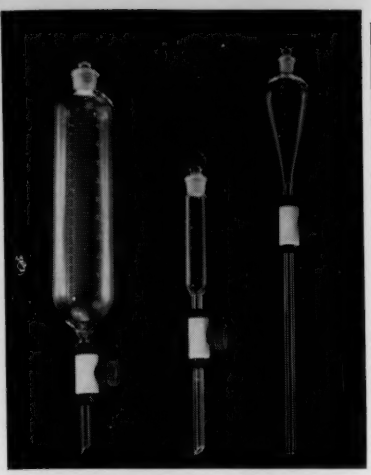

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same pace, the life expectancy should reach almost 100 years by the end of this century. These prolongations of the life span can be explained through the fact that diseases, particularly in infancy, are much better controlled than they used to be. Although tuberculosis could be controlled to a certain extent one hundred years ago, nevertheless 500 out of every 100,000 persons died (this includes deaths in all countries of the world). Last year the mortality in the United States and in some European countries was down to about 10 per 100,000. Streptomycin, the first of the drugs used in the medical treatment of tuberculosis, was soon followed by others, such as para-aminosalicylic acid. Lately it has been discovered that isonicotinic acid hydrazide has healing effects in tuberculosis. Since 1940, the year of the discovery of the first antibiotic, many epidemics and infectious diseases have been treated with great success—diesases such as pneumonia, syphilis, typhoid fever, typhus, tularemia, undulant fever, plague, and cholera.

The amazing success of the application of antibiotics also caused great social changes, which I will discuss shortly. The almost complete abolition of diseases of childhood as a result of the use of antibiotics can be shown best in the figures on tubercular meningitis. Until 1946, with no chemotherapy available for this disease, the mortality was 100 percent. In 1947, with the introduction of streptomycin, the mortality was 80 percent. In 1950, with para-aminosalicylic acid therapy also in use, the mortality was 50 percent. And in 1953, with isonicotinic acid hydrazide complementing the other two drugs, mortality was down to 15 percent. Countries which previously had a great mortality among infants, which served as a brake on the constant rise of the population, now are facing serious problems in the fields of economics and population policy, such as birth control.

The prolongation of the life span of the average human being poses the problem of finding ways to look after older people and of finding work for them. Countries which are already overpopulated and have a steadily increasing number of jobless people face a serious social problem. A slow decrease in the number of hospitals and sanatoria can be predicted. Just consider the formerly prolonged treatment of tuberculosis. The increased tendency toward ambulatory treatment of patients should not be overlooked, either. In the future, a short period in the hospital will be followed by treatment on the outside by the family physician. Greater safety in the use of vaccine preparations has been made particularly evident with the development of vaccines against virus infections such as poliomyelitis. An increase in the production of food has been


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made possible through elimination of various infectious diseases in plants and animals and, moreover, improvements in food preservation have been made by adding antibiotics to food products. Another tremendous area of progress is that of the psychological attitude toward disease. There need be, in the future, no more panic and fear of epidemics and diseases which used to decimate the human race. The fact that venereal diseases can be controlled harbors also a great danger and may lead to an unimaginable degree of carelessness concerning mental and physical hygiene. The appearance of certain new diseases needs definite attention. This fact is connected with the reduction of natural resistance. Nevertheless, one should not overemphasize this problem.

The situation of the physicians has changed too. They have at their disposal a great many antibiotics which they can use, but they have to judge in each case whether, by killing the primary cause of the disease, they may not activate a secondary disease germ. No physician should allow himself to let antibiotics replace his reasoning.

The extensive use of antibiotics is another social aspect. In the first place, there exists the tendency toward self-treatment. Then there is the patient's expectation of a rapid cure, and if it is not forthcoming, he blames the physician or the antibiotic. As Waksman remarked, "In the case of severe chronic diseases or diseases of unknown etiology, such as cancer, many have come to expect miracles from newly discovered antibiotics and other drugs. Excessive promises have been made, even to the effect that 'cures' will be forthcoming after so much money has been spent for research."

Paul Hermann Müller (Basel, Switzerland), who was awarded the Nobel prize in 1948 for his discovery of DDT as a contact poison, talked about the further development of the antibiotics and application in agriculture. Ever since 1942, the so-called "antibiotics era," more than 3500 different substances with antibiotic effect have been discovered, but only 17 preparations have been made available commercially. It is surprising to see their fast spread and increased use in many fields. Since 1950, the production of these extremely helpful chemicals has tripled.

New applications for the protection of staple goods and plants, and in agriculture, are constantly found. In the use of antibiotics for plant protection, the most limited range of action is against fungi; yet the fungus diseases are more important than the bacteria against which the antibiotics have a relatively broad range of action.

One of the few antbiotics with a definite fungicide effect is cycloheximid or actidion, which is a by-product in the production of streptomycin. Actidion is effective against mildew and mint rust and is also used against the disease of cherry trees (Schrotschuss) caused by *Clasteroporium carpophilum* AD. In contradistinction to inorganic fungicides it can be used on fruit-bearing trees. For the protection of stored food, and in animal breeding, antibiotics are used more and more. In 1954 about 250 tons were added to animal food, as a growth stimulant. The cause of this effect, however, could not be explained definitely. Thus it is understandable that a certain skepticism still prevails.

New experiments, carried on mostly in Germany, show that effects similar to those produced by antibiotics can be obtained with ordinary substances (for example, nasturtium or horseradish) without side effects (for example, change in the intestinal flora).

The addition of antibiotics to easily perishable foods also presents a certain danger, which should not be overlooked; it creates the possibility that human beings may be constantly given small, uncontrolled amounts of antibiotics. As a result, there is the possibility of a gradual development of resistance by important pathogenic bacteria. Besides this, a change in the intestinal flora may

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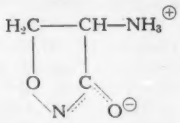
also appear. In view of these reasons, it is forbidden in the United States to add antibiotics to uncooked food.

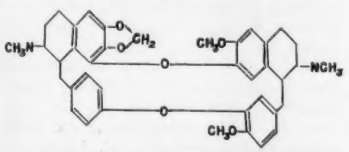
In the last three years, more antibiotics have been introduced; these I will mention briefly:

*Cycloserine*: This has a very broad range of action on Gram-positive and Gram-negative bacteria and against strains of *Mycobacterium tuberculosis*. It is a 4-amino-3-isoxazolidon with a relatively good stability in an alkaline environment, and has the following structure:



*Gonyleptidin*: This antibiotic was isolated from the glands of a South African spider of the Gonyleptidae family, and is effective against 18 kinds of bacteria. It consists of a mixture of various benzochinones in which 2,3-dimethyl-, 2,5-dimethyl-, and 2,3,5-trimethyl benzochinone predominate.

*Cefaranthin*: This is an alkaloid and antibiotic, isolated from the roots of the *Stephania cepharantha* Hayata. It is effective as a preventive for tuberculosis, leprosy, and whooping cough, and inactivates snake poison and toxine of tetanus. It has the following structure:



In this connection, gibberellic acid should also be mentioned. This is not a real antibiotic but, in very small amounts, has physiological effects. The active material, which is extracted from the mushroom *Gibberella fujkuroi*, strongly influences the growth of plants. In this way the growth of geraniums, roses, sunflowers, beans, pepper, corn, and so on, can be tripled after 4 weeks of treatment. But for application on a large scale in agriculture, more practical experience with this new product is needed.

H. ROTTA

*Stuttgart, Germany*

*We are indebted to Mrs. Heidi Steffen of Purdue University for translating this report from the German.*

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*16–23.* Scientific Information, intern. conf., Washington, D.C. (Mrs. M. Sheppard, Intern. Conf. on Scientific Information, Natl. Acad. of Sciences–Natl. Research Council, 2101 Constitution Ave., Washington 25.)

*17–19.* Association of Military Surgeons of the U.S., Washington, D.C. (R. E. Bitner, Suite 718, New Medical Bldg., 1726 Eye St., NW, Washington 6.)

*17–20.* Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. (H. B. Callen, Dept. of Physics, Univ. of Pennsylvania, Philadelphia.)

*17–22.* Radiological Soc. of North America, Chicago, Ill. (D. S. Childs, Sr., 713 E. Genesee St., Syracuse 2, N.Y.)

*18–20.* Air Pollution, 1st natl. conf., Washington, D.C. (Dept. of Health, Education, and Welfare, U.S. Public Health Service, Washington 25.)

*18–20.* Standards, 9th natl. conf., New York, N.Y. (American Standards Assoc., 70 E. 45 St., New York, N.Y.)

*18–21.* Weather Radar Conf., 7th, Miami Beach, Fla. (K. C. Spengler, American Meterological Soc., 3 Joy St., Boston 8, Mass.)

*18–22.* Pan-American Dental Cong., Mexico City, Mexico. (Association Dental Mexicana, Sinaloa 9, Mexico 7, DF, Mexico.)

*19–21.* Electrical Techniques in Medicine and Biology, 11th annual conf., Minneapolis, Minn. (O. H. Schmitt, Univ. of Minnesota, Minneapolis.)

*20–22.* Acoustical Soc. of America, 56th meeting, Chicago, Ill. (K. Kramer, 3839 Grand Ave., Western Springs, Ill.)

*20–22.* American College of Cardiology, New Orleans, La. (P. Reichert, Empire State Bldg., New York 1.)

*20–22.* International Symp. on Tuberculosis, Philadelphia, Pa. (M. J. Schwartz, Deborah Sanatorium & Hospital, 642 Widener Bldg., Philadelphia 7.)

*20–23.* American Anthropological Assoc., Washington, D.C. (W. S. Godfrey, Jr., APA Logan Museum, Beloit College, Beloit, Wisc.)

*20–23.* European Confederation of Agriculture, Vienna, Austria. (M. H. Abegg, Confédération Européenne Agriculture, Brougg (Argovie), Switzerland.)

*21–22.* American Soc. of Animal Production, annual, Chicago, Ill. (H. H. Stonaker, Animal Husbandry Dept., Colorado State Univ., Fort Collins, Col.)

*24–26.* Fluid Dynamics, division of American Physical Soc., San Diego, Calif. (R. J. Emrich, Dept. of Physics, Lehigh Univ., Bethlehem, Pa.)

*24–26.* Mechanisation of Thought Processes, symp., Teddington, Middlesex, England. (The Secretary, Natl. Physical Lab., Teddington, Middlesex.)

*24–6.* Plant Specialists, 4th Latin American conf., Santiago, Chile. (R. Cortazar, Departmento de Investigaciones Agricolas, Ministerio de Agricultura Casilla 4088, Santiago, Chile.)

*27-29.* Central Assoc. of Science and Mathematics Teachers, 58th annual, Indianapolis, Ind. (N. G. Sprague, Indianapolis Public Schools, 1644 Roosevelt Ave., Indianapolis 18.)

*28–6.* International Conf. of Social Work, 9th intern., Tokyo, Japan. (J. R. Hoffer, Intern. Conf. of Social Work, 345 East 46 St., New York 17, N.Y.)

*30–5.* American Soc. of Mechanical Engineers, 79th annual, New York, N.Y. (O. B. Schier, ASME, 29 W. 39 St., New York 18.)

### December

*1–3.* American Soc. of Refrigerating Engineers, New Orleans, La. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

*1–4.* Entomological Soc. of America, Salt Lake City, Utah. (R. H. Nelson, 1530 P St., NW, Washington, D.C.)

*1–5.* American Rocket Soc., 13th annual, New York, N.Y. (A. F. Denham, 925 Book Bldg., Detroit 26, Mich.)

*2.* Scientific Study of Glass, 11th technical meeting of the European Union, Paris, France. (Société française de céramique, 44, rue Copernic, Paris 16e.)

*2–4.* Electric Steel Furnace Conf., 17th, Cleveland, Ohio. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

*2–5.* American Medical Assoc., clinical meeting, Minneapolis, Minn. (G. F. Lull, 535 N. Dearborn St., Chicago, Ill.)

*3.* Animal Care Panel, 9th annual, Chicago, Ill. (R. J. Flynn, Argonne Natl. Laboratory, Lemont, Ill.)

*3–5.* American Inst. of Electrical Engineers, St. Petersburg, Fla. (N. S. Hibsham, AIEE, 33 W. 39 St., New York 18.)

*3–5.* Eastern Joint Computers Conf., Philadelphia, Pa. (G. W. Bailey, IRE, 1 E. 79 St., New York 21.)

*3–5.* Global Communications, 2nd natl. symp., St. Petersburg Beach, Fla. (M. R. Donaldson, 1501 72 St. N., St. Petersburg.)

*4–5.* Vehicular Communications, annual, Chicago, Ill. (G. W. Bailey, IRE, 1 E. 79 St., New York 21.)

*5–7.* American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

*6.* American Rheumatism Assoc., Rochester, Minn. (E. F. Hartung, ARA, 580 Park Ave., New York, N.Y.)

*6–11.* American Acad. of Dermatology and Syphilology, Chicago, Ill. (R. R. Kierland, Mayo Clinic, Rochester, Minn.)

*7–10.* American Inst. of Chemical Engineers, annual, Cincinnati, Ohio. (F. J. Van Antwerpen, 25 W. 45 St., New York, N.Y.)

*8–10.* American Nuclear Soc., winter, Detroit, Mich. (ANS, P.O. Box 963, Oak Ridge, Tenn.)

*9–10.* Conference on Learning Effectiveness, Univ. of Pennsylvania, Philadelphia, Pa. (Air Force Office of Scientific Research, Air Research and Development Command, U.S. Air Force, Washington 25.)

*10–16.* American Acad. of Optometry, annual, Boston, Mass. (C. C. Koch, 1502 Foshay Tower, Minneapolis, Minn.)

*12–13.* Association for Research in Nervous and Mental Disease, annual, New York, N.Y. (R. J. Masselink, 700 W. 168 St., New York 32.)

*15–17.* American Soc. of Agricultural Engineers, winter, Chicago, Ill. (J. L. Butt, American Soc. of Agricultural Engineers, St. Joseph, Mich.)

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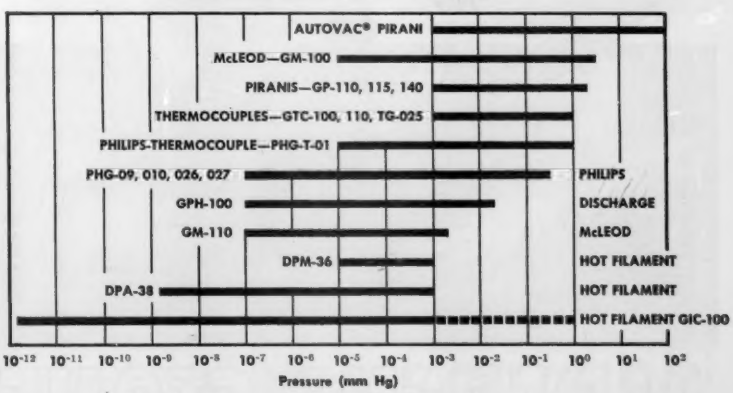


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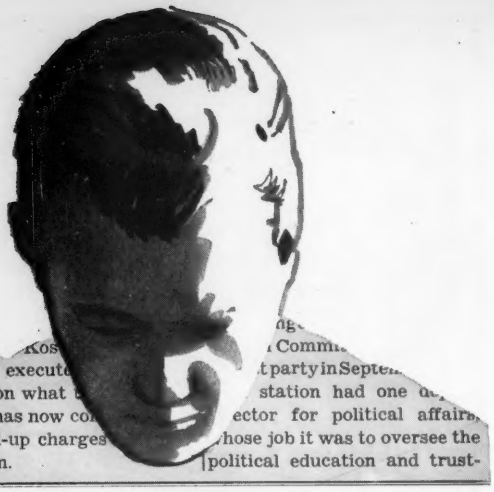

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*15–19.* Radiation Biology, 2nd Australian conf., Melbourne, Australia. (J. H. Martin, Physics Dept., Cancer Inst. Board, 483 St. Lonsdale St., Melbourne, Victoria.)

*17.* Institute of Aeronautical Sciences, Washington, D.C. (R. R. Dexter, IAS, 2 E. 64 St., New York 21.)

*18–20.* American Physical Soc., Los Angeles, Calif. (K. K. Darrow, APS, Columbia Univ., New York 27.)

*26–31.* American Assoc. for the Advancement of Science, annual, Washington, D.C. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C.)

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The following 47 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Committee on the Social Aspects of Science (C. D. Leake, Ohio State Univ. College of Medicine, Columbus, Ohio). 27 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (J. W. Buchta, Univ. of Minnesota, Minneapolis, Minn.). 28 Dec.

Academy Conf. (J. A. Yarbrough, Meredith College, Raleigh, N.C.). 27–28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 27 Dec.

American Assoc. of Clinical Chemists (Miss E. G. Frame, Clinical Center, Natl. Institutes of Health, Bethesda 14, Md.). 29–30 Dec.

American Assoc. of Scientific Workers (R. J. Rutman, 6331 Ross St., Philadelphia 44, Pa.).

American Astronautical Soc. (R. Fleisig, 58 Kilburn Rd., Garden City, N.Y.). 27–30 Dec.

American Geophysical Union (W. E. Smith, AGU, 1515 Massachusetts Ave., NW, Washington 5).

American Meteorological Soc. (K. Spengler, 3 Joy St., Boston, Mass.).

American Nature Soc. (S. Mulaik, Biology Dept., Univ. of Utah, Salt Lake City). 26–30 Dec.

American Physiological Soc. (F. A. Hitchcock, Ohio State Univ., Columbus).

American Political Science Assoc. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington, D.C.). 27 Dec.

American Psychiatric Assoc. (L. J. West, Univ. of Oklahoma School of Medicine, Oklahoma City 4). 27–28 Dec.

American Soc. of Criminology (D. E. J. MacNamara, Dean, New York Inst. of Criminology, Inc., 40 E. 40 St., New York 16). 27–28 Dec.

American Soc. of Naturalists (J. Schultz, Inst. for Cancer Research, Philadelphia, Pa.).

American Soc. of Photogrammetry (R. G. Ray, U.S. Geological Survey, Washington 25). 29 Dec.

American Soc. of Zoologists (G. Moment, Dept. of Biology, Goucher College, Towson, Baltimore 4, Md.). 27–29 Dec.

American Sociological Soc. (K. Davis, Inst. of International Studies, Univ. of California, Berkeley 4). 29 Dec.

Association of American Geographers, Middle Atlantic Div. (J. E. Guernsey,

9707 Parkwood Dr., Bethesda, Md.). 29 Dec.

Association for Computing Machinery (J. Douglas, Mathematics Dept., Rice Inst., Houston, Tex.).

Astronomical League (Miss G. C. Scholz, 410 Mason Hall Apts., Alexandria, Va.). 26 Dec.

Biometric Soc. (J. Cornfield, Johns Hopkins Univ., Baltimore, Md.). 30 Dec.

American Statistical Assoc. (E. Glazer, 305 George Mason Dr., Falls Church, Va.). 30 Dec.

Conference on Scientific Communication Problems (G. L. Seeilstad, Technical Reports Group, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.). 28–30 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 30 Dec.

Ecological Soc. of America (D. E. Davis, Johns Hopkins Univ., School of Hygiene, Baltimore, Md.).

History of Science Soc. (M. C. Leikind, 1334 Aspen St., NW, Washington 12). 29 Dec.

Instrument Soc. of America (O. L. Linebrink, Battelle Memorial Inst., Columbus, Ohio). 30 Dec.

International Geophysical Year (H. Odishaw, National Acad. of Sciences, Washington 25). 29–30 Dec.

Junior Scientists Assembly (K. C. Johnson, Supervising Director of Science, District of Columbia Public Schools, Woodrow Wilson High School, Washington 16). 27–28 Dec.

Metric Assoc. (J. T. Johnson, 694 W. 11 St., Claremont, Calif.).

National Acad. of Economics and Political Science (D. P. Ray, Hall of Government, George Washington Univ., Washington, D.C.). 27 Dec.

National Assoc. of Biology Teachers (P. Klinge, Jordan Bldg., Indiana Univ., Bloomington). 26–30 Dec.

National Assoc. for Research in Science Teaching (E. S. Obourn, U.S. Office of Education, Washington 25). 26–30 Dec.

National Assoc. of Science Writers (J. Billard, U.S. News and World Report, Washington, D.C.).

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 30 Dec.

National Science Teachers Assoc. (W. A. Kilgore, District of Columbia Teachers College, Washington 9). 26–30 Dec.

National Speleological Soc. (W. E. Davies, 125 Greenway Blvd., Falls Church, Va.). 28–29 Dec.

Philosophy of Science Assoc. (C. W. Churchman, Case Inst. of Technology, Cleveland, Ohio).

Pi Gamma Mu (Mrs. Effie B. Urqhart, Winfield, Kan.).

Scientific Research Soc. of America (D. B. Prentice, 56 Hillhouse Ave., New Haven 11, Conn.).

Sigma Delta Epsilon (Mrs. V. L. Blackford, 2630 Adams Mill Rd., NW, Washington 10). 26–30 Dec.

Society for General Systems Research (R. L. Meier, Mental Health Research Inst., Univ. of Michigan, Ann Arbor). 29 Dec.

Society for Industrial Microbiology, Washington section (W. N. Ezekiel, Bur. of Mines, Washington 25). 27–28 Dec.

Society of the Sigma Xi (T. T. Holme, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Society of Systematic Zoology (G. W. Wharton, Dept. of Zoology, Univ. of Maryland, College Park). 26–30 Dec.

United Chapters of Phi Beta Kappa (C. Billman, 1811 Q St., NW, Washington, D.C.). 27 Dec.

Washington Acad. of Sciences (G. W. Irving, ARS, U.S. Dept. of Agriculture, Washington 25).

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*27–29.* American Economic Assoc., Chicago, Ill. (J. W. Bell, AEA, Northwestern Univ., Evanston, Ill.)

*27–29.* Econometric Soc., Chicago, Ill. (R. Ruggles, Box 1264 Yale Station, Yale Univ., New Haven, Conn.)

*27–30.* American Folklore Soc., New York, N.Y. (MacE. Leach, AFS, Univ. of Pennsylvania, Philadelphia, Pa.)

*28–30.* Archaeological Inst. of America, Cincinnati, Ohio. (L. A. Campbell, AIA, Dept. of Classics, Brooklyn College, Brooklyn, N.Y.)

*29–30.* National Council of Teachers of Mathematics, New York, N.Y. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

*28–30.* Western Soc. of Naturalists, Seattle, Wash. (J. P. Harville, San Jose State College, San Jose 14.)


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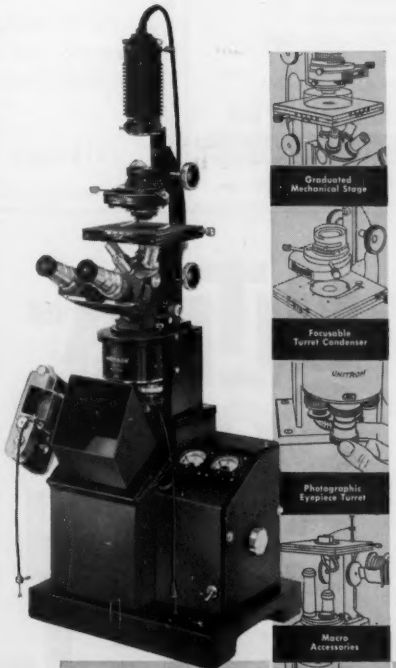


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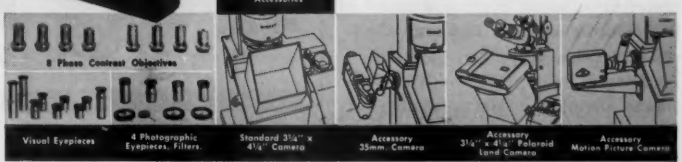
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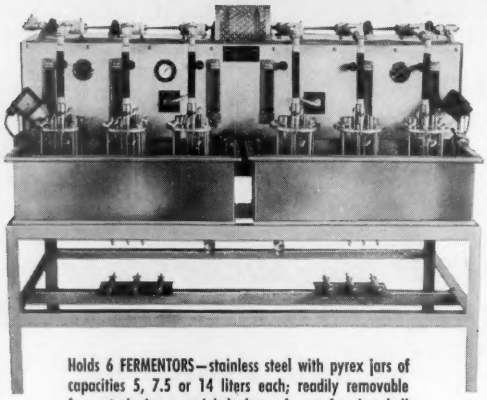

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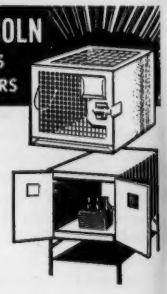


• American-Lincoln animal cages of all types ranging from single units to large four compartment sizes. Special cages, spare pans, racks, etc., built to order. Incubators for egg embryo and container work used by America's leading scientific institutions.

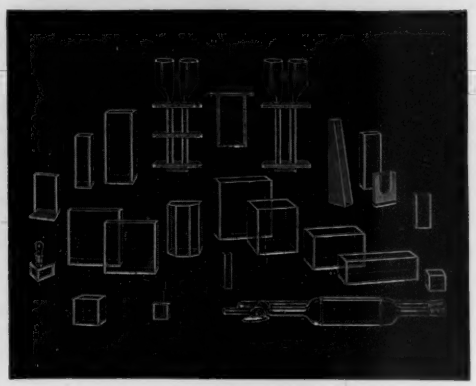
*Write for New Catalog*

**AMERICAN-LINCOLN INCUBATOR CO.**

**Dept. AS**

**NEW BRUNSWICK, N.J.**

# GLASS ABSORPTION CELLS made by KLETT



Makers of Complete Electrophoresus Apparatus

SCIENTIFIC APPARATUS
Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York

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*. . . the only complete line of microbiological reagents and media*

Culture Media
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*Complete Stocks Fast Service*
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DIFCO LABORATORIES
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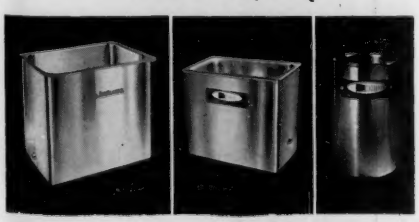

## Aloe-Narda Ultrasonic Cleaning Equipment is *Fast / Low Cost / Efficient*

The right generator plus the proper transducerized tank furnishes the ideal ultrasonic system for cleaning almost anything you can think of . . . Glassware, hot lab apparatus, medical instruments, electronic components, optical and technical mechanisms . . . and so on. Whatever the problem, these ultrasonic systems can be the answer to doing it faster, cheaper, and more efficiently.

Operation is simple and easy. Just plug into any 115V, 60 cycle outlet. Fill the tank. Add detergent. Flip the switch. Immediately, swift precision cleaning economies are yours. Excellent for other purposes too — like brightening, polishing, decontaminating, pickling, deburring, plating and degassing.

*To determine the exact model you need, write for prices and more details, now.*

**aloe scientific** *DIVISION OF A. S. ALOE COMPANY*
5655 Kingsbury • St. Louis 12, Missouri
*Fully-Stocked Divisions Coast to Coast*

aloe

# Equipment

*The information reported here is obtained from manufacturers and from other sources considered to be reliable.* Science *does not assume responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 922.*

■ OVEN operates at temperatures up to 300°F. Chamber size is 3 by 36 by 48 in. Air is circulated by a 1500 ft³/min fan operated by a 1 hp three-phase motor. A 7-day timer and a circular chart recorder are provided. (Pereny Equipment Co., Dept. 412)

■ COLD-JUNCTION COMPENSATOR is applicable to thermocouple devices. In use, the measuring thermocouple is connected to the input terminals of the compensator, the measuring device to the output terminals. When a selector switch is set for the type of thermocouple, a temperature-sensitive Wheatstone bridge in the compensator produces the necessary compensating voltage. Compensation accuracy is ±1°F in ambient levels from 32° to 120°F. The instrument weighs 6 lb and measures 5⅜ by 8 by 5 9/16 in. (Technique Associates, Inc., Dept. 405)

■ ACCELEROMETERS are capable of continuous operation at temperatures from −100° to +500°F with accuracy ±5 percent of reading. Bender-type piezoelectric elements are used with resonant frequencies as high as 30 kcy/sec and senstivities up to 10 mv/*g*. Ranges covered are 0.01 to 1000 *g* and 3 to 10,000 cy/sec. (Gulton Industries Inc., Dept. 391)

■ DIGITAL BAROMETER is a null-balancing electromechanical instrument that provides five-place readings of atmospheric pressure. The instrument operates on the weigh-beam principle in which transfer of barometer fluid from one column to another causes an unbalance moment that actuates a servo motor to restore equilibrium. Resolution is 1 in 30,000; repeatability, 0.002 in.-Hg. Outputs other than digital are available. (Dynametrics Corporation, Dept. 400)

■ PRESSURE TRANSDUCER uses proving-ring principle and a four-arm strain-gage bridge. The transducer will handle most gases and also extremely corrosive liquids. Pressure ranges are 300 to 10,000 lb/in.² gage. Linearity is 0.25 percent, hysteresis 0.5 percent. Ambient temperature may be −65° to 250°F. Natural mechanical frequency for the 300 lb/in.² range is 2500 cy/sec. (Taber Instrument Corp., Dept. 404)

■ FLOW-METERING SYSTEMS provide rate and totalizing indication and introduce pressure drops less than 2.5 lb/in². Impeller-type transmitters are used to sense flow. The transmitters are available in stainless steel or aluminum alloy with temperature range from less than −350°F to greater than +300°F. Accuracy is ±1 percent over the range 3 to 600 gal/min. (Revere Corp. of America, Dept. 407)

■ VACUUM FURNACE produces a uniform horizontal hot zone 6 in. in diameter by 12 in. long. Continuous operation to 2200°F is permissible. Vacuum is produced by a 4-in. pumping system with capacity of 720 ft/min³ at $10^{-4}$ mm-Hg. The four standard loading and cooling arrangements available include provision for a continuous work-exchanger loading and cooling zone. (General Vacuum Corp., Dept. 408)

■ MERCURY-VAPOR PUMP is a metal, water-cooled three-stage pump with a speed of 40 liter/sec of air in the $3 \times 10^{-4}$ to $2 \times 10^{-2}$ mm-Hg range. Ultimate pressure of $10^{-8}$ mm-Hg can be attained with a cold trap at −63°C. Peak speed of 52 liter/sec occurs at 10 μ-Hg. (Consolidated Eletrodynamics Corp., Dept. 413)

JOSHUA STERN
*National Bureau of Standards*

**NOW** IMPROVED SAMPLING PROCEDURES WITH **BAIRD-ATOMIC'S**

**FLAME PHOTOMETER**

Papers recently published are available on newly developed sampling techniques using the standard, B-A Flame Photometer. These papers are:

FCA-1 Procedures for Calcium Determinations

FPK-1 Sodium and Potassium Determinations from the same dilution.

More B-A Flame Photometers are in use than all other makes combined because:

- SIMPLICITY of operation allows very rapid work — 80 or more determinations can be made in an hour.
- REPRODUCIBILITY within ±½ of 1%, normal operation.
- HIGH SENSITIVITY of the instrument permits detection of as little as 0.004 mEq/L.
- 10 TIMES GREATER ACCURACY with B-A's Multilayer interference filters than with standard filters.

*Send for the papers on the new techniques and procedures using B-A's Flame Photometer.*

**Baird-Atomic, Inc.**
33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

Baird Atomic

# PERSONNEL PLACEMENT

**CLASSIFIED:** 25¢ per word, minimum charge $4.25. Use of Box Number counts as 10 additional words. Payment in advance is required.

**COPY** for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

**DISPLAY:** Rates listed below—no charge for Box number. Monthly invoices will be sent on a charge account basis — provided that satisfactory credit is established.

| | |
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| **Single insertion** | **$26.00 per inch** |
| **13 times in 1 year** | **24.00 per inch** |
| **26 times in 1 year** | **23.00 per inch** |
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**Replies to blind ads** should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

## POSITIONS WANTED

Chief Biochemistry Technician, capable of setting up or running a clinical biochemistry laboratory. Interested in opening. Box 213, SCIENCE. 10/10, 17, 24

Microbiologist, Ph.D. Years of experience in medical bacteriology and chemotherapy, production of antibiotics, tissue culture and virology. Interested in appointment in virology and bacteriology. Box 224, SCIENCE. X

Ph.D. Organic Chemistry; since 1951, director research laboratory, medical school and teaching hospital. Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

## POSITIONS OPEN

(a) **Biochemist**; M.S., Ph.D. to head department, new laboratory to be completed early 1959; 400-bed general hospital; to $9000; New York City vicinity. (b) **Bacteriologist**; M.S., Ph.D.; full charge of busy department, very large general hospital; about $7000; mideastern city 150,000. (c) **Research Biochemist**; Ph.D. trained steroid chemistry, chromatography; cancer research in affiliation large teaching hospital; $7000; East. (d) **Bacteriologist**; interesting opportunity to head busy department, 400-bed general hospital; to $6000 or more; Mideast. (e) **Endocrinologist**; M.D., Ph.D., well grounded in broad aspects of endocrinology, emphasis medical-biological phases; head and organize endocrinologic research department, important midwestern laboratories. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

**Biologist.** Completed graduate work leading to Ph.D.; $5880–$7344; to study ecology and pollution of estuaries of Virginia. Virginia Fisheries Laboratory, Gloucester Point, Virginia. 9/19, 26; 10/3, 10, 17, 24, 31

**Pharmacologist.** Opportunity with ethical pharmaceutical company, West Coast. Ph.D. or equivalent. Please send full résumé to Personnel, Riker Laboratories, Inc., Northridge, California. X

(a) **Physiologist** well trained in respiratory physiology; M.D. or Ph.D.; research and teaching at graduate level; university cancer research unit; West. (b) **Pharmacologist**, Ph.D., experienced in gastrointestinal field; pharmaceutical company, East; up to $10,500. (c) **Biochemist** with a knowledge of animal physiology and an interest in hormones; duties consist of working under direction of senior biochemist on basic research problems in biochemistry; large chemical company, South. (d) **Pathologist** to serve as medical director, large pharmaceutical company; duties include conducting seminars in various parts of the country; $20,000. S10-4, Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

**SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, $1.00. Yearly (12 issues) membership, $5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22 N.Y. ew**

## POSITIONS OPEN

**BIOCHEMIST**

**Ph.D. in biochemistry, preferably experienced in isolation of enzymes, proteins, materials derived from cells. Write**

**Dr. Gustav J. Martin, Research Director,**
**THE NATIONAL DRUG COMPANY**
**Haines & McCallum Streets**
**Philadelphia 44, Penna.**

Biologist, Ph.D., with experience in tissue culture and related fields needed by an expanding eastern pharmaceutical company. Person will undertake responsible position in cancer and virus research. Please indicate qualifications. Box 217, SCIENCE. 10/10, 17

## POSITIONS OPEN

M.D. with research training and experience in pharmacology or physiology, to assist director of pharmacology, in leading pharmaceutical company. Excellent opportunities for research and advancement. Inquiries will be treated strictly confidential. Box 219, SCIENCE. 10/10, 17, 24

**NEW WORLD-WIDE GRADUATE AWARD DIRECTORIES** for American Scientists, teachers, librarians to subsidize their education and research. Stipends $200–$10,000. Volume I (1957), $3; volume II (no duplication), special prepublication offer until 1 November, $2; both volumes $4 until 1 November. Limited edition. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. ew

**USE THIS EASY SELF-MAILER to obtain further information**

**17 October 1958**

*Readers' Service*

**Information Requisition**

**It's simple: Mark—Clip—Fold—Mail—No stamp required**

**This coupon is for your convenience—to facilitate your requests for further information about advertised products and items in Equipment.**

**From:**

**Name** ..... **Position** .....

**Company** .....

**Street** .....

**City** ..... **Zone** .... **State** .....
(Please print or type)

**Mark, clip coupon—FOLD HERE along this line—mail**

**Postage Will be Paid by Addressee**

**No Postage Stamp Necessary If Mailed in the United States**

**BUSINESS REPLY CARD**
First Class Permit #12711 New York, N.Y.

*Readers' Service*

**To: SCIENCE MAGAZINE**
**Room 740**
**11 West 42 Street**
**New York 36, New York**

**Fasten Here Only**
**Staple, Tape, Glue**

# The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

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| Single insertion | $26.00 per inch |
| 13 times in 1 year | 24.00 per inch |
| 26 times in 1 year | 23.00 per inch |
| 52 times in 1 year | 22.00 per inch |

**For PROOFS on display ads,** copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

## PROFESSIONAL SERVICES

**LaWall & Harrisson**
RESEARCH & CONTROL LABORATORIES
Div. 8, 1921 Walnut St., Philadelphia 3, Pa.
SINCE 1870

**Food & Drug PROBLEMS**
Pharmacological BACTERIOLOGICAL CHEMICAL

**HISTOLOGY MICROBIOLOGY**
Consultation
Research Technical Services
**SCIENTIFIC LABORATORY SERVICES**
2 Melissa Way Terre Haute, Ind.

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**Your sets and files of scientific journals**

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

Scientific and Technical books to sell? Send stamped, self-addressed envelope for list of those we want to buy. (Scholarly list also available.) **Oster's, Box 111,** Times Sq. Sta., New York 36, N.Y.

## SUPPLIES AND EQUIPMENT

**ANIMAL CAGES and ACCESSORY EQUIPMENT**

BUY DIRECT FROM MANUFACTURER

SHIPMENT OF STANDARD ITEMS FROM STOCK

**HOELTGE BROS., Inc.**
1919 Gest St. Cincinnati 4, Ohio
*Write for Illustrated Catalog*

**Sprague-Dawley, Inc.**
*Pioneers in the development of the standard laboratory rat.*
Sprague-Dawley, Inc.
P.O. Box 2071, Madison 5, Wisconsin
Phone: CEdar 3-5318

**WHITE MICE**
Hamsters, Guinea Pigs and Rats
J. E. STOCKER Box 4 Ramsey, N.J.

**albino rats** *
**Descendants of the Sprague-Dawley and Wistar Strains*
•
Hypophysectomized Rats
•
HENRY L. FOSTER, D.V.M.
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THE CHARLES RIVER BREEDING LABS.
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**$Cl^{36}$ $P^{32}$ $C^{14}$ etc.**
other High Radiopurity tagged compounds
NUCOR **ISOTOPES SPECIALTIES COMPANY INC.**
BOX 688 BURBANK, CALIFORNIA
DIVISION OF NUCLEAR CORPORATION OF AMERICA, INC.

**• HYPOPHYSECTOMIZED RATS**
Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc.
8159 South Spaulding Ave., Chicago 29, Ill.

17 October 1958

# *Readers' Service*

## Information Requisition

**Use this easy self-mailer to obtain further information about items or literature from the Equipment section as well as from advertised products.**

### EQUIPMENT

**Circle below desired number corresponding to:**

391 400 404 405 407 408 412 413

### ADVERTISERS IN THIS ISSUE

In list below, check page number of advertiser from whom you would like more information. If more than one item appears in ad, letters (A, B, C) are used to indicate particular items available in order of appearance in advertisement. Where more than one ad appears on page, **"U" indicates upper ad, "L" lower ad, "I" inside ad, "M" middle ad,** and **"O" outside ad.** Advertisements in Personnel Placement and Market Place are not keyed. A multiplicity of items is indicated by *. Readers are requested to specify on this coupon the particular item in which they are interested; otherwise, the request cannot be processed.

| | | | | |
|---|---|---|---|---|
| ☐ 862* | ☐ 863* | ☐ 864 | ☐ 865 | ☐ 866 |
| ☐ 868 | ☐ 908 | ☐ 909, UI | ☐ 909, UO | ☐ 909, LI-A |
| ☐ 909, LI-B | ☐ 909, LI-C | ☐ 909, LM | ☐ 909, LO | ☐ 910, LO |
| ☐ 910, LI | ☐ 911, I | ☐ 911, O | ☐ 912 | ☐ 913* |
| ☐ 914* | ☐ 915 | ☐ 916 | ☐ 917 | ☐ 918, UO |
| ☐ 918, LO | ☐ 918, LM | ☐ 918, LI | ☐ 919, UI | ☐ 919, UO |
| ☐ 919, L | ☐ 920 | ☐ 924 | | |

# APPLICATION FOR HOTEL RESERVATIONS

## 125th AAAS MEETING

## Washington, D.C., December 26-31, 1958

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in Washington. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Washington and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

**As in any city, single-bedded rooms at minimum rates may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague.** Most hotels will place comfortable rollaway beds in rooms or suites at $2.00 to $2.50 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

### AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

**Rates for Rooms with Bath**

**Hotels with an asterisk have sessions in their public rooms.** For a list of headquarters of each participating society and section, see page 151, *Science*, July 18.

| Hotel | Single | Double Bed | Twin Bed | Suite |
|---|---|---|---|---|
| *Dupont Plaza | $10.00–11.00 | $13.00–14.00 | $13.00–14.00 | $21.00–27.00 |
| *Sheraton-Park | 8.00–12.00 | 12.00–14.50 | 11.00–16.00 | 20.00–60.00 |
| *Shoreham | all 9.00 | all 12.00 | all 12.00 | 20.00–50.00 |
| *Statler | all 10.00 | all 14.00 | all 14.00 | 24.00–30.00 |
| *Washington | 7.00– 8.00 | 11.00–12.50 | 11.00–12.50 | 24.50–45.00 |
| *Willard | 10.00–12.50 | 13.00–17.00 | 14.00–18.00 | 25.00–35.00 |
| Roosevelt | 7.00– 9.00 | | 10.00–12.00 | 18.00–24.00 |
| Sheraton-Carlton | 12.00–17.00 | | 17.00–21.00 | |
| Windsor Park | all 9.00 | all 14.00 | all 14.00 | 13.00–18.00 |

### THIS IS YOUR HOUSING RESERVATION COUPON

**AAAS Housing Bureau**
**1616 K Street, N.W.**
**Washington 6, D.C.**

**Date of Application** .....

Please reserve the following accommodations for the 125th Meeting of the AAAS in Washington, D.C., Dec. 26–31, 1958:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

**(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)**

.....

.....

**First Choice Hotel** ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
**(These must be indicated—add approximate hour, a.m. or p.m.)**

NAME .....
**(Individual requesting reservation)** **(Please print or type)**

ADDRESS .....
**(Street)** **(City and Zone)** **(State)**

***Mail this now to the Housing Bureau.*** **Rooms will be assigned and confirmed in order of receipt of reservation.**

The DS8 basic scintillation detector weighs less than 5 ounces, and is just 1" in diameter.

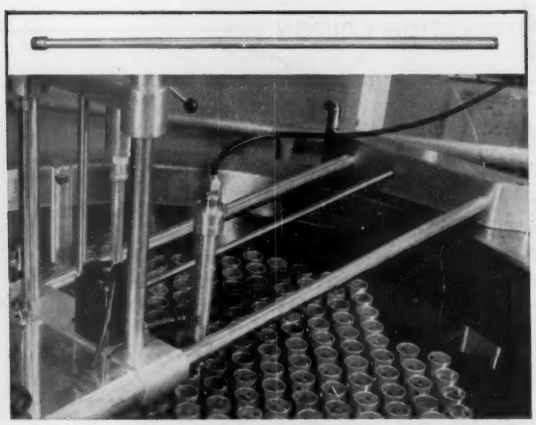
# Versatile New Scintillation Probe Detects Fast or Slow Neutrons, Gammas, and Betas

Completely new, the Nuclear-Chicago Model DS8 Scintillation Probe provides precision detection of fast or slow neutrons, gamma and beta radiation. Utilizing a unique new 10 stage, ¾" photomultiplier tube and a completely transistorized electronic circuit, the probe is completely water tight and corrosion proof. A resolution time in the microsecond region permits its use in extremely high radiation fields.

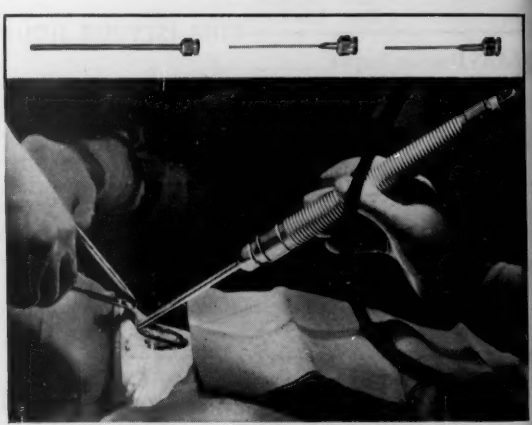
Two neutron probes are offered for flux measurements in reactors or subcritical assemblies. The neutron sensitive volume is confined to the very ends of the 42" probes so that "point" measurements may be made easily. Probe housings are quickly removed to permit substitution of slow neutron or fast neutron sensitive phosphors. These long probes can also be supplied with sodium iodide crystals for gamma detection.

Three needle probes with 2.5 mil wall thicknesses are available for beta and gamma detection. They are unequalled for measuring radiation in almost inaccessable areas where highest resolution is essential.

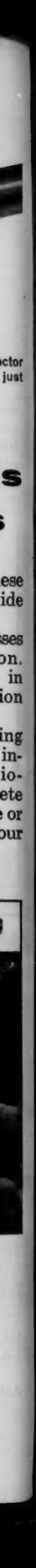
For more than 12 years we have been designing and manufacturing high quality, dependable instruments for detecting and measuring radioactivity. We will be glad to furnish you complete information on this new DS8 Scintillation Probe or on other Nuclear-Chicago instrumentation or our Research Quality Radiochemicals.



Shown here being used with Nuclear-Chicago Model 9000 Subcritical Training Reactor to measure slow neutron flux at various points in the lattice, neutron probes are 42" long and are available in two diameters, 3/4" and 11/32".



Shown here in use during thyroid surgery, Model DS8 is offered with three beta-gamma sensitive needle probes 2 mm, 3 mm and 6 mm in diameter, 10 cm to 15 cm in length. All probes are easily interchanged by loosening a simple hand nut.

*Fine Instruments - Research Quality Radiochemicals*

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